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BULLETIN OF MARINE SCIENCE OF THE GULF AND CARIBBEAN

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NEMERTEANS FROM FLORIDA AND VIRGIN ISLANDS

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ABSTRACT

The present paper presents 24 species of Nemerteans from Florida and Virgin Islands. The species nos. 9, 17, 18 and 24 are new for science; nos. 2, 3, 8, 10, 11, 14, 21 and 22 are additions to the list of Central and South American Nemerteans given by Corrêa (1954, p. 3-11).

Palaeonemertini

- 1- *Tubulanus pellucidus* (Coe, 1895)
- 2- *Tubulanus rhabdotus* Corrêa, 1954
- 3- *Carinomella lactea* Coe, 1905

Heteronemertini

- 4- *Baseodiscus delineatus*, var. *curta* (Hubrecht, 1879)
- 5- *Lineus socialis* (Leidy, 1855)
- 6- *Lineus albocinctus* Verrill, 1900
- 7- *Cerebratulus leucopsis* Coe, 1902
- 8- *Cerebratulus lineolatus* Coe, 1905

Hoplonemertini

- 9- *Emplectonema osceolai*, new species
- 10- *Nemertopsis bivittata* (Chiaje, 1841)
- 11- *Ototyphlonemertes pellucida* Coe, 1943
- 12- *Ototyphlonemertes evelinae* Corrêa, 1948
- 13- *Ototyphlonemertes fila* Corrêa, 1953
- 14- *Ototyphlonemertes lactea* Corrêa, 1954
- 15- *Oerstedtia dorsalis* (Abildgaard, 1806)
- 16- *Zygonemertes virescens* (Verrill, 1879)
- 17- *Zygonemertes simoneae*, new species
- 18- *Zygonemertes cocacola*, new species
- 19- *Amphiporus ochraceus* (Verrill, 1873)
- 20- *Amphiporus texanus* Coe, 1951
- 21- *Prostomatella enteroplecta* Corrêa, 1954
- 22- *Prostomatella merula* Corrêa, 1954
- 23- *Tetrastemma candidum* (Müller, 1774)
- 24- *Tetrastemma worki*, new species

INTRODUCTION

Almost all species treated in the present paper were collected by me from October 1958 to February 1959 during my stay at The Marine Laboratory, University of Miami, Fla.

I am deeply indebted to Dr. F. G. Walton Smith, to Dr. Hilary Moore and to Dr. Gilbert L. Voss, respectively Director, Assistant Director, and Research Associate Professor of The Marine Laboratory for the kind hospitality conferred on me. Particular mention should be made of Mr. Robert C. Work to whom I wish to express my great indebtedness for the help he gave in collecting specimens.

This paper was made possible by financial aid from the John Simon Guggenheim Memorial Foundation, New York, and the Brazilian National Research Council, Rio de Janeiro, which awarded me a fellowship to study in the United States and contributed to pay my trip expenses. To both I wish to present my sincere thanks.

To Professor Dr. G. L. Voss I am grateful for revising my manuscript linguistically and reading the proofs.

LOCALITIES

- 1—Virginia Key, Miami. Among algae together with many invertebrates on the panels hung under the pier of The Marine Laboratory, University of Miami, for study of anti-fouling paint. Intertidal zone and below. (See Smith, Walton F. G., Robert H. Williams, and Charles C. Davis, 1950 fig. 2.)
 - 1—*Tubulanus pellucidus* (Coe, 1895)
 - 2—*Tubulanus rhabdotus* Corrêa, 1954
 - 3—*Baseodiscus delineatus*, var. *curta* (Hubrecht, 1879)
 - 4—*Emplectonema osceolai*, new species
 - 5—*Nemertopsis bivittata* (Chiaje, 1841)
 - 6—*Oerstedia dorsalis* (Abildgaard, 1806)
 - 7—*Zygonemertes virescens* (Verrill, 1879)
 - 8—*Zygonemertes simoneae*, new species
 - 9—*Zygonemertes cocacola*, new species
 - 10—*Amphiporus ochraceus* (Verrill, 1873)
 - 11—*Amphiporus texanus* Coë, 1951
 - 12—*Prostomatella enteroplecta* Corrêa, 1954
 - 13—*Prostomatella merula* Corrêa, 1954
 - 14—*Tetrastemma candidum* (Müller, 1774)
 - 15—*Tetrastemma worki*, new species
- 2—Virginia Key, Miami. In coarse sand under the pier of The Marine Laboratory, University of Miami. Intertidal zone.
 - 1—*Otocyphlonemertes evelinae* Corrêa, 1948
- 3—Virginia Key, Miami. Among algae, *Enteromorpha* sp. and

- Acanthophora spicifera* (Vahl) Börgesen, in front of The Marine Laboratory, University of Miami. Intertidal zone.
- 1—*Tubulanus rhabdotus* Corrêa, 1954
 - 2—*Cerebratulus lineolatus* Coe, 1905
 - 3—*Nemertopsis bivittata* (Chiaje, 1841)
 - 4—*Oerstedia dorsalis* (Abildgaard, 1806)
 - 5—*Zygonemertes virescens* (Verrill, 1879)
 - 6—*Prostomatella enteroplecta* Corrêa, 1954
 - 7—*Prostomatella merula* Corrêa, 1954
- 4—Virginia Key, Miami. Among algae, sea-grass and under logs in tide-pools on Virginia Beach. Intertidal zone.
- 1—*Tubulanus rhabdotus* Corrêa, 1954
 - 2—*Tetrastemma worki*, new species
- 5—Virginia Key, Miami. In coarse sand from Virginia Beach. Intertidal zone.
- 1—*Ototyphlonemertes pellucida* Coe, 1943
 - 2—*Ototyphlonemertes evelinae* Corrêa, 1948
 - 3—*Ototyphlonemertes fila* Corrêa, 1953
 - 4—*Ototyphlonemertes lactea* Corrêa, 1954
- 6—Key Biscayne, Miami. Among algae from old roots of mangroves. Intertidal zone.
- 1—*Tubulanus rhabdotus* Corrêa, 1954
 - 2—*Tetrastemma worki*, new species
- 7—Key Biscayne, Miami. Among algae, Polychaete tubes and sea-grass from the marina intertidal zone.
- 1—*Tubulanus rhabdotus* Corrêa, 1954
 - 2—*Cerebratulus leucopsis* Coe, 1902
- 8—Bear Cut, channel between Virginia Key and Key Biscayne, Miami. Dredged at about 4 m.
- 1—*Cerebratulus leucopsis* Coe, 1902
- 9—Biscayne Bay, Miami. Dredged at about 4 m.
- 1—*Carinomella lactea* Coe, 1905
- 10—MacArthur Causeway, Miami. Among algae. Intertidal zone.
- 1—*Tubulanus rhabdotus* Corrêa, 1954
- 11—Miami Beach, Fla. Among algae and other growths from jetties. Intertidal zone.
- 1—*Nemertopsis bivittata* (Chiaje, 1841)
- 12—Key Largo, Fla. Among *Padina* and sea-grass. Intertidal zone
- 1—*Oerstedia dorsalis* (Abildgaard, 1806)

- 2—*Zygonemertes virescens* (Verrill, 1879)
- 3—*Tetrastemma candidum* (Müller, 1774)
- 4—*Tetrastemma worki*, new species
- 13—Marco Island, Gulf of Mexico, West coast of Florida. In coarse sand. Intertidal zone.
 - 1—*Ototyphlonemertes evelinae* Corrêa, 1948
- 14—Virgin Islands. Among algae under rocks. Intertidal zone.
 - 1—*Lineus socialis* (Leidy, 1855)
 - 2—*Lineus albocinctus* Verrill, 1900

Tubulanus pellucidus (Coe, 1895)

Figures 1-4

References. Coe, 1895, p. 515-517 pl. 13 fig. 4 pl. 15 fig. 5 (full description); 1905, p. 122-125 (full description); 1940, p. 256 (habitat and distribution); 1943, p. 227-228 (short description, biology); 1951, p. 329 (geographical distribution); 1951a, p. 157-158 f. 3 (short description).

Material. One worm in November 1958.

Further occurrence. Southern New England to Northern Florida on the Atlantic coast and Pensacola, Fla., on the Gulf coast; from Monterey Bay to San Diego, Cal., on the Pacific coast.

Description. The filiform, living, mature female worm (Fig. 1) was about 20 mm long and 0.3 mm in maximum width. Both ends are rounded. The anterior end is a little wider than the rest of the body. It is flattened dorso-ventrally and separated from the cylindrical trunk by a slight constriction. The color is whitish with a median-dorsal and a ventral band of very pale yellow as a consequence of the cream colored eggs. There are neither eyes nor cephalic furrows.

The epidermis is high and extremely rich in deeply staining glands. The basement membrane is thin. Muscle crosses between the two circular muscular layers are well developed and occur only on the dorsal side of the body (Fig. 2,c). Cephalic glands are entirely wanting.

The mouth (Fig. 2,m) is a slit situated immediately behind the slight constriction between head and trunk at the posterior level of the brain. It is lined by a villous and ciliated epithelium. The oesophagus and the stomach are also lined by a villous, ciliated and glandular epithelium.

The rhynchodaeum opens sub-terminally and its epithelium is very rich in glands (Fig. 3,i). Rhynchocoel and proboscis do not extend into the posterior half of the body. The proboscis wall (Fig. 4) is

composed of a high external epithelium (t), a thin layer of circular muscles (x), a thick layer of longitudinal muscles (u) and the flat internal epithelium (e). The two longitudinal proboscicial nerves (v) are situated immediately under the external epithelium.

A pair of very large cephalic lacunae (Fig. 3,a) is united anteriorly by a broad, median lacuna. They are lined by a distinct epithelium. Behind the brain there are two lateral vessels (Fig. 2,b).

The pre-cerebral nerves (Fig. 3,n) are well developed and situated under the epidermis. Besides the two pairs of cerebral ganglia there is a pair of esophageal nerves (Fig. 2,o) which follow the esophagus for some distance backwards. One median-dorsal nerve is present (Fig. 2,d). Cerebral sense organs are little developed and represented only by slight epidermic grooves. Lateral sense organs are small epidermic grooves at the posterior level of the esophagus.

The present specimen showed large ovocytes situated dorsally to the lateral nerve cords.

Discussion. Only three species of the genus are known in Caribbean waters (Corrêa, 1954, p. 4, 12): *Tubulanus pellucidus*, *floridanus* Coe, 1951, and *rhabdotus* Corrêa, 1954. The two last species are longer than *pellucidus* and have rings along the entire length of their body, lighter than the ground color in *floridanus* and darker in *rhabdotus*. *T. pellucidus* has no rings.

Tubulanus rhabdotus Corrêa, 1954

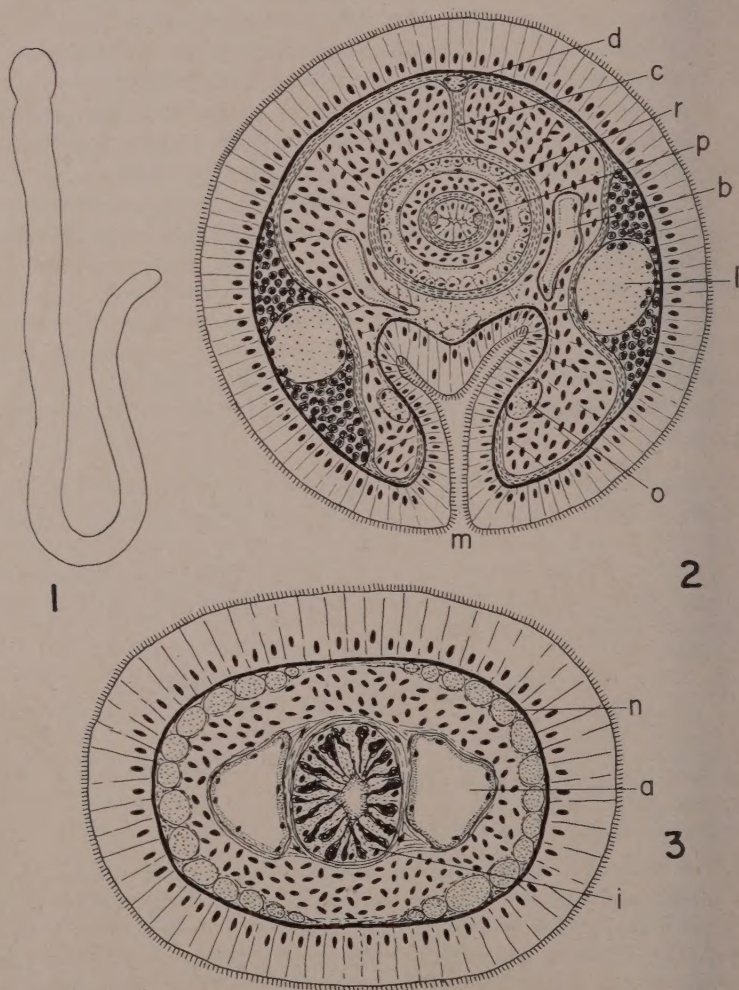
Figures 5-6

References. Corrêa, 1954, p. 12-25 pl. 1 figs. 1-6 pl. 2 figs. 7-9 pl. 3 figs. 10-11 pl. 4 figs. 12-18 (full description).

Material. Several worms in winter 1958/59.

Further occurrence. Coast of São Paulo, Brazil.

Description. The living mature worms (Fig. 5) are up to 25 cm in length and about 1 mm in maximum width. Preservation in hot formalin makes the worm shorter, wider, and its tail takes a spiral shape. The color is still present after preservation. As in certain other species of the genus (Yamaoka, 1940, p. 212) it often shows autotomy of the hind end and extrusion of the posterior gut. The ground color is ocher-greenish. Behind the constriction between cephalic plate and trunk there are several black rings irregularly broad and irregularly set apart from each other. The first four rings are wider and not as close to each other as the posterior ones. On the ground color



FIGURES 1-3. *Tubulanus pellucidus* (Coe, 1895). FIG. 1. Total view of preserved worm. FIG. 2. Transverse section at mouth level. FIG. 3. Transverse section at rhynchodaeum level.

LETTERING

a—cephalic lacuna, b—lateral blood vessel, c—muscle cross, d—median-dorsal nerve, i—rhynchodaeum, l—lateral nerve cord, m—mouth, n—pre-cerebral nerve, o—esophageal nerve, p—proboscis, r—rhynchocoel.

there are black scattered spots disposed in regular rows. Both the ground color and the black rings have scattered light halos. The first black ring is incomplete ventrally at the level of the mouth and laterally at the level of the cephalic furrows. The cephalic plate is ocher, triangle-shaped, rounded anteriorly and flattened dorso-ventrally. It has black spots on the sides of the proboscis pore, black scattered spots and light halos. The lateral sense organs (Fig. 6,1) are well visible on the sides within the fourth black ring. Transparent tubes secreted by the worms, not seen in Brazilian specimens (Corrêa, 1954, p. 13), were frequent around the Florida worms. The latter are much more numerous than those from Brazil, longer and lighter.

The rhynchodaeum opens sub-terminally on the anterior tip of the cephalic plate. It begins in the epidermis, pierces the basement membrane and occupies a centro-median position between the anterior blood vessels. The lumen is narrow and lined by a high and glandular epithelium. Light cells of vacuolised aspect occur in the dorsal region of the ectal rhynchodaeal epithelium. Most entally they are also ventrally present forming a ring around the lumen. Cephalic glands are not developed in this and other species of *Tubulanus* (Bürger, 1897-1907, p. 409) nor in most Palaeonemertini (Bürger, 1895, p. 229, 517). Friedrich (1936a, p. 103) found differences between the dorsal and ventral wall of the rhynchodaeum of *T. borealis* Friedrich, 1936. Some differences occur also in *rhabdotus* where besides the vacuolised cells there are eosinophilous gland cells. The absence of cephalic glands and the similarity of the vacuolised cells of the rhynchodaeum with that type of glands allows to homologize both types. On the limit between rhynchodaeum and rhynchocoel there is a rhynchodaeal postero-ventral caecum and a rhynchocoelic antero-dorsal caecum. The proboscidal longitudinal nerves, two in number, single in the beginning, originate on the right side of the ventral nerve commissure. The rhynchocoel wall is composed of flat epithelium and a layer of circular muscles. Dorsally the latter layer is thicker by the juxtaposition of the circular internal muscles of the body wall, and ventrally it is followed by the central plate of longitudinal muscles. At the stomach and anterior gut level there are some longitudinal bodies in the wall of the rhynchocoel, the rhynchocoelic bodies, described by Friedrich in *T. borealis* (1936a, p. 107). They are united with the lateral blood vessel by dorsal branches which run through the rhynchocoelic wall. The proboscis wall is composed of an external high and glandular epithelium, the external basement

membrane, and two layers of muscles. The circular layer is thin and missing distally; the longitudinal layer is thick and present in the whole proboscis. The proboscicidal nerves are situated between the external basement membrane and the circular layer. Internally to the muscular layers there is the internal basement membrane and the internal epithelium.

Discussion. *T. rhabdotus* is now the third species of the genus described from Florida waters (Corrêa, 1954, p. 4). It differs from *pellucidus* (Coe, 1895) by its dark rings along the entire length of the body and from *floridanus* Coe, 1951, also by its rings which contrary to those in *floridanus* are darker than the ground color.

Carinomella Coe, 1905

The most striking peculiarities of the genus indicated by Coe (l. c., p. 127) are: a massive band of longitudinal muscles between the proboscis sheath and the intestinal canal, most highly developed posterior to the nephridial region; the position of the lateral blood spaces internal to the inner circular muscles in the anterior esophageal region; the pouch-like outfoldings of the intestine, which are however not true diverticula; the structure of the proboscis; the enormous cephalic blood lacunae; the extremely thin basement membrane; the total absence of cerebral sense organs; the anastomosing fibers of the integument.

I could not find in my sections the massive band of longitudinal muscles, the so-called longitudinal muscular plate, situated between rhynchocoel and intestine. As I only had small anterior fragments comprising a short distance behind the nephridial region, it may have been thicker in the lost posterior parts. The length given by Coe is 50-100 mm which shows that the wanting posterior fragments were much longer than my anterior ones. All other characteristics agree with Coe's description of the genus.

Carinomella lactea Coe, 1905

Figure 8

References. Coe, 1905, p. 127-143 pl. 5 figs. 45-49 pl. 6 figs. 50-54 pl. 7 figs. 55, 56 pl. 8 figs. 57, 58 pl. 9 figs. 59-61 pl. 10 figs. 63-65 pl. 11 figs. 66-72 (full description); 1940, p. 257 (habitat and distribution).

Material. Two anterior fragments in January 1959.

Further occurrence. Monterey, San Pedro and San Diego, Cal., U. S. A.

Description. The two fragments (Fig. 8), already preserved, measured about 5 mm in length and 1 mm in maximum width. One of them had a pointed end and the other was rounded. A slight constriction separates the head from the trunk. The color of the anterior end was opaque white followed by a broad dark brown band which encircles the body. This fades gradually posteriorly towards the broken line of the fragments. In sections the integument is darkly pigmented at the level of the brown band. The lateral sense organs (1) are easily seen on the sides of the body near the posterior border of the brown band. Each organ appears as an oval depression bordered with a white or colorless rim. Eyes are lacking.

The glandular epidermis is remarkably thick in proportion to the other layers in the anterior portions of the body. The basement membrane is extremely thin. The longitudinal and external circular muscular layers are well developed in the whole body. A thick internal circular muscular layer extends throughout the esophageal region and then suddenly almost disappears at the beginning of the intestinal region. Cephalic glands are completely wanting as well as other types of sub-epithelial glands.

The large mouth is situated immediately behind the brain.

The rhynchodaeal pore is situated sub-terminally on the ventral surface, and the rhynchodaeum itself between the two cephalic blood lacunae. The rhynchocoel wall is composed of a thin epithelium lining the cavity, a thin layer of longitudinal muscles and also a thin layer of circular muscles. The proboscis shows a bulb-like expansion near the anterior end followed by a constriction through which a narrow canal leads to the posterior chamber, the longest part of the organ.

The attachment of the proboscis, the septum, seems to be only a differentiation of the longitudinal muscles of the body which are stronger dorsally. The proboscis wall is diverse along its length. The thickest part, the bulbous expansion, has a high glandular outer epithelium, a thin layer of circular muscles, a thicker layer of longitudinal muscles and the internal epithelium. The two longitudinal probosciscal nerves are embedded in connective tissue beneath the external epithelium. The rhynchocoelic fluid is rich in cells.

The blood system consists principally of a large cephalic lacuna and a single pair of lateral, post-cerebral vessels. The nephridial tubules, situated in the stomacal region, enter into close relation with the outer wall of the lateral blood vessels, causing infoldings in its wall of the shape of nephridial glands.

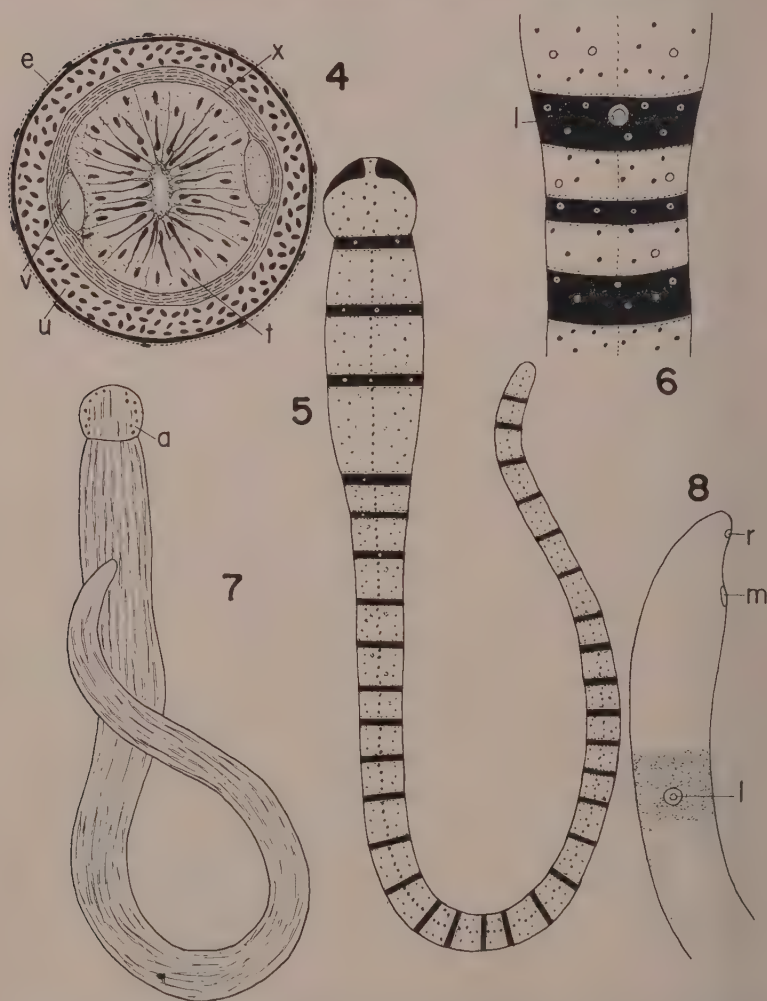


FIGURE 4. *Tubulanus pellucidus* (Coe, 1895). Transverse section of proboscis. FIGURES 5-6. *Tubulanus rhabdotus* Corrêa, 1954. FIG. 5. Dorsal view of preserved worm. FIG. 6. Lateral view of preserved worm at level of lateral sense organ. FIG. 7. *Baseodiscus delineatus*, var. *curta* (Hubrecht, 1879). Dorsal view of living worm. FIG. 8. *Carinomella lactea* Coc, 1905. Antero-lateral view of preserved worm.

LETTERING

a—eyes, e—external proboscis epithelium, l—lateral sense organ, m—mouth, r—rhynchodaeum pore, t—internal proboscis epithelium, u—longitudinal proboscis muscles, v—longitudinal proboscis nerves, x—circular proboscis muscles.

The brain, nerve commissures, and lateral nerve cords are situated outside the outer layer of circular muscles. Cerebral sense organs are absent.

Baseodiscus delineatus var. *curta* (Hubrecht, 1879)

Figure 7

References. Bürger, 1895, p. 601-603 pl. 4 figs. 3-5, 7, 9, 17 pl. 19 figs. 5, 13-15, 21 pl. 22 fig. 41 (full description); 1896, p. 25-26 pl. 2 fig. 6 (short description); 1899, p. 8 (synonymy); Wijnhoff, 1925, p. 102-103 pl. 5 textfig. 2a-e (short description as an independent species); Coe, 1940, p. 261 (short description, distribution); Corrêa, 1956, p. 199-201 pl. 2 figs. 6-11 (full description as independent species); 1958, p. 443 pl. 1 figs. 1-2 (systematic considerations as var. of *delineatus*).

Material. One worm in November 1958.

Further occurrence. The species, *B. delineatus* (Chiaje, 1825) and its var. *curta* (Hubrecht, 1879) are cosmopolitan (Bürger, 1897-1907, pl. 22), and both occur together in the same regions (Coe, 1940, p. 261). To the American localities of *delineatus*, Florida, Puerto Rico, Barbados, and Chile (Coe, 1902, p. 226; 1940, p. 260; 1951a, p. 180) and of the variety *curta*, Curaçao (Wijnhoff, 1925, p. 102), West Indies, and Chile (Coe, 1940, p. 261), I added the coast of São Paulo, Brazil (Corrêa, 1958, p. 443), and for the variety at least as far as the coast of Bahia, Brazil. The Atlantic northern-most finding of the genus is Bermuda (Coe, 1951a, p. 180).

Description. The living mature worm (Fig 7) measured 6 cm in length and 0.8 mm in maximum width. Preserved it measured respectively 4 cm and 1 mm. The ground color is light yellow with several irregular, narrow, brown-reddish stripes which are lighter on the ventral surface. The proboscis pore lies ventrally on the tip of the head, and the mouth behind the constriction between cephalic plate and trunk. Cephalic furrows are absent. Several eyes (a) are disposed in irregular rows on both sides of the cephalic plate.

The rhynchodaeal epithelium is high and ciliated. The proboscoidal muscular septum belongs to the closed type. The rhynchocoel wall is composed of an epithelium, thick basement membrane, thin layer of longitudinal muscles and thicker layer of circular muscles related to the internal longitudinal muscles of the body. The proboscoidal wall is composed of an irregular external epithelium, the external basement membrane, a nerve plexus, a layer of longitudinal muscles, a thinner layer of circular muscles, the internal basement membrane, and the internal flat epithelium, poor in nuclei. There are no proboscoidal muscle crosses.

Discussion. *B. curtus* was considered by Coe (1940, p. 261) as a var. of *delineatus*. Wijnhoff (1925, p. 102) who had only material

of *curtus*, classified it as an independent species. The only difference between both is the length of the body, from about 30 to 100 cm in *delineatus* and from about 5 to 20 cm in *curta*. All the characteristics of *curta* given by Wijnhoff occur also in *delineatus*. Both agree in their external and internal anatomy (Corrêa, 1958, p. 443).

Lineus socialis (Leidy, 1855)

References. Verrill, 1892, p. 424-425 pl. 37 figs. 8, 8a pl. 38 figs. 7, 7a (short description); Coe, 1943, p. 244-246 textfigs. 33-38, 49-51 (short description); 1951, p. 329 (distribution); 1951a, p. 159-160 textfigs. 6-9 (short description). *Material.* Five fragments in January 1959.

Further occurrence. From Bay of Fundy to Northern Florida, and on the Gulf coast westward to Texas.

Description. The sum of all fragments makes a complete worm about 9 cm long. The maximum breadth is 3 mm. The color of the already preserved fragments is uniformly blackish except for the tip of the head which is pure white both dorsally and ventrally. The anterior extremity is acutely pointed and the posterior rounded. There is a pair of longitudinal slits which reach the anterior level of the large mouth. The head is not separated from the trunk by any constriction.

The poor state of preservation and absence of the proboscis did not allow for an anatomical study.

Discussion. As the fragments were slender, the head narrow, and the cephalic slits long, they differ from *L. ruber* (Müller, 1771) the nearest species which has opposite characteristics (Coe, 1943, p. 244). The habit of coiling in a spiral known of the present species could not be seen because I received preserved fragments.

Lineus albocinctus Verrill, 1900

Figures 9-11

References. Verrill, 1900, p. 598 pl. 70 (short description); Coe, 1902, p. 228-229 (short description); 1951, p. 330 textfig. 2 (short description); 1951a, p. 181-182 textfig. 26 (short description).

Material. One anterior and five posterior fragments in January 1959.

Further occurrence. Bermuda, Puerto Rico, Biscayne Bay, Miami, Fla.

Description. The anterior fragment was about 10 mm long and the biggest posterior 15 mm. The width was 4 mm. The ground color was dark brown, nearly black, both on dorsal and ventral surfaces of the already preserved fragments. The anterior fragment (Figs. 9-10) has a series of white rings incomplete dorsally; and the other fragments had (Fig. 11), besides these rings, also white lateral spots, 2 or 3 in number, situated on both sides between the incomplete

rings. There is a constriction between the cephalic lobe and the trunk. The cephalic lobe has a white plate dorsally (Fig. 9), and two others ventrally (Fig. 10). In front of the mentioned constriction there is a broad white band, more or less incomplete ventrally. On both sides of the head the longitudinal cephalic slits attain the constriction. Behind it and ventrally lies the large mouth (Fig. 10, m).

The poor state of preservation and absence of the proboscis did not allow for a study of the inner organs.

Discussion. Coe (1951, 1951a) had only posterior fragments at his disposal which agree with the corresponding parts of my worms. The shape and extension of the incomplete white rings is variable and agrees with that described by Coe in the posterior portion of the body.

From Verrill's diagnosis I can deduce some differences between his specimens, seen alive, and mine, received preserved. They are: head usually wider than body, and underside whitish in Verrill's specimens. In preserved worms the head can be narrower than the body, and the underside can become darker. Size, dorsal color, neck with a wider white band, and head with a white dorsal spot agree in Verrill's and my worms.

Cerebratulus leucopsis Coe, 1902

Figure 12

References. Coe, 1902, p. 227 (short description); 1951, p. 330 (distribution); 1951a, p. 183 (short description); Wijnhoff, 1925, p. 105 pl. 5 figs. 8-10 pl. 7 fig. 8 (short description).

Material. Four fragments in January 1959.

Further occurrence. Puerto Rico, Curaçao, Key West, Fla.

Description. The biggest anterior (Fig. 12) and posterior fragments measured in life 6 cm in length and 6 mm in maximum width. The presumable tail was lost during collecting and the proboscis was evaginated. The anterior end is pointed and narrower than the rest of the body. The anterior part of the body is cylindrical, the posterior flattened. The worm showed high capacity to contract. The color is light pink, gradually lighter forwards. The tip of the head is pure white. The brain shows dark by transparency. The longitudinal cephalic slits (1) are long and quite deep. Eyes are absent. The proboscis was lost at preservation.

Cerebratulus lineolatus Coe, 1905

References. Coe, 1905, p. 196-197 pl. 4 fig. 44 (short description); 1940, p. 275 (habitat and distribution); MacGinitie 1949, p. 163 textfig. 44.

Material. One anterior fragment in November 1958.

Further occurrence. San Pedro, Newport and San Diego, Cal.; Puerto Refugio, Angel de la Guardia, and at Willards Pt., Gonzaga Bay, Lower Cal., Mexico.

Description. The living fragment was 15 mm long and 0.3 mm broad. The anterior end is slender and acutely pointed, not demarcated from the body. It seems to me that Coe (1905, pl. 4 f. 44) and McGinitie (1949, p. 163 f. 44) had also only anterior fragments, as they gave figures of this part. Perhaps these worms are easily broken and only anterior fragments are known. The color is pale gray with numerous fine, irregular, interrupted brown lines on dorsal and ventral surface. The brain is red by transparence. The cephalic slits are moderately long and very deep. There are about three eyes on each side of the head.

The wall of the proboscis is composed of a high external epithelium, an external layer of longitudinal muscles, an external layer of circular muscles, an internal layer of longitudinal muscles, an internal layer of circular muscles, and a flat internal epithelium. There are crosses between the two circular layers both ventrally and dorsally but they are not very distinct.

Emplectonema Stimpson, 1857 (Friedrich, 1955)

Long, filiform or flattened Nemerteans with short rhynchocoel; sub-epithelial glands often numerous, variously distributed or lacking; cephalic glands generally well developed, but short; esophagus opens into rhynchodaeum; caecum generally short, with pouches; exceptionally an esophageal caecum; cerebral sense organs either small far in front of brain. or large and shortly anterior to brain.

Based on the type of the genus, *E. gracile* (Johnston, 1837), from the Gulf of Naples. In order to prepare a definitive diagnosis of *Emplectonema*, I added (Corrêa, 1955, p. 68) some more elements to its diagnosis. They are: several pre-cerebral eyes; muscular layers reach tip of head; dorso-ventral muscles present; long antero-lateral intestinal pouches; gut with lateral pouches; proboscoidal septum of closed type; dorsal blood vessel originated from right blood vessel and lateral nerve cords with only one strand of fibers.

E. gracile shows long cephalic glands reaching as far backwards

as the level of the stomach. However the new species has short cephalic glands, as was stated in Friedrich's diagnosis.

Friedrich (1955, p. 172) suggested that the genus *Emplectonema* be split into two groups on the basis of the position and size of the cerebral sense organs. One group has small organs situated some distance in front of the brain, the second large organs close to the brain. Based on Wijnhoff's theory about the origin of the tip of the head, the position of the cerebral sense organs, before or behind the pre-cerebral septum, could also allow for a division of the genus *Emplectonema*. However the position of the cerebral sense organs in relation to the pre-cerebral septum is only known in *Emplectonema bocki* Brunberg, 1959 p. 64-65. The type of the genus shows cerebral sense organs before the pre-cerebral septum (Corrêa, 1955, pl. 1 figs. 1, 3).

Some attempts have been made (Friedrich, 1955; Corrêa, 1955) to clarify the exact separation between the emplectonematid genera *Emplectonema* Stimpson, 1857, and *Nemertopsis* Bürger, 1895. They were hitherto separated by only one artificial character: *Emplectonema* has two or many, *Nemertopsis* has four eyes. Brunberg (1959, p. 64) had difficulties in judging the taxonomic position of her worms. Most of her specimens had four eyes, but in several cases some of these showed a tendency to split up into two smaller ones, and individuals with 5, 6, 7 or 8 ocelli were not rare (l. c., p. 61).

I agree with her that the emplectonematid genera are a heterogeneous group and that some of the characters apply only to the type species. The natural separation of the monostiliferous nemerteans must yet be done.

Emplectonema osceolai, new species

Figures 15-16

Material. Two worms in January 1959.

Type. One set of 12 μ transverse sections of the anterior part of the body (3 slides) and a posterior nonsectioned part, both under the number M 1 deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, Brazil.

Description. The living worms (Fig. 16) reach 12 cm in length and 0.5 mm in maximum width. The color is uniformly yellowish-white. There is one transverse cephalic furrow, distinct in life and V-shaped. The anterior end is flattened dorso-ventrally, snake-like shaped and separated from the trunk by a constriction. There are about 20 eyes distributed in irregular rows on each side of the head.

The epidermis is high throughout the body, until $80\ \mu$, and poor in glands. The basement membrane, about $10\ \mu$ thick, is wider than the subjacent circular muscles. In whole mounts the basement membrane shows as a black longitudinal stripe underneath the epidermis on the sides. The longitudinal muscular layer is wider than the circular one but thinner than the epidermis. Both layers of muscles reach the tip of the head. Before the brain there are some dorso-ventral muscular fibers. The cephalic glands are voluminous, shaped as large and small clusters, situated dorsally, laterally and ventrally to the rhynchodaeum. They do not extend beyond the posterior level of the cerebral sense organs.

The esophagus opens into the rhynchodaeum. It has a narrow lumen but distinct nuclei in its epithelium. The stomach, rich in glands, is large, and its epithelium was almost completely filled by secretion.

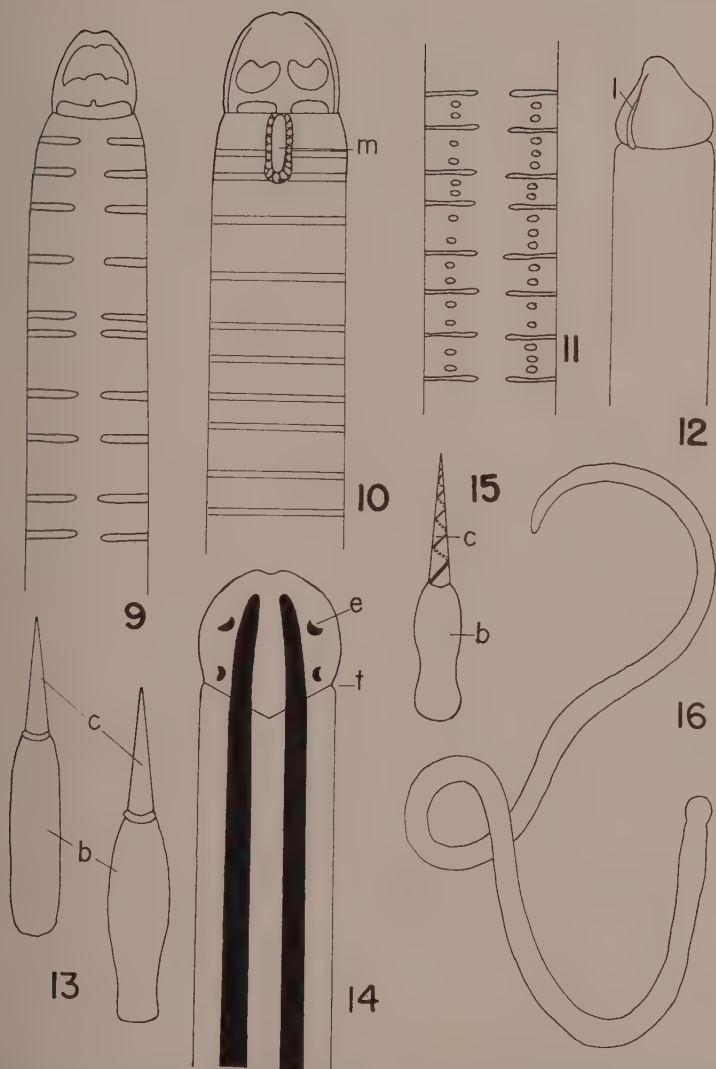
The rhynchodaeum is thin in front of the cerebral sense organs and thick behind them. The rhynchocoel is short. The proboscis has an extremely thin anterior chamber and a very thick posterior chamber. The base of the central stylet (Fig. 15, b) is pear-shaped and as long as the stylet itself (c). There are two pouches each bearing only one accessory stylet. All stylets have spiral grooves. The proboscoidal septum belongs to the closed type. It is composed of moniliform muscular bands.

In front of the brain there are two blood vessels which are united anteriorly by a commissure. Behind the brain there are three blood vessels, one dorsal and two lateral ones. The dorsal blood vessel, situated between the rhynchocoel and the gut, originates from the right blood vessel.

Nephridial ducts can be seen dorsally and ventrally at the posterior level of the brain and the first third of the stomach.

The brain has the shape of a complete ring around the rhynchodaeum. The plate consists of a nucleus of nervous fibers, nervous cells and two commissures, one dorsal and the other ventral to the rhynchodaeum. Behind the commissures the ring divides into four ganglia, two dorsal and two ventral ones. The lateral nerve cords, originated from the ventral ganglia, have only one strand of fibers. They are situated ventro-laterally.

The cerebral sense organs are small and lie far in front of the brain and in front of the proboscoidal septum. The cerebral canal opens into



FIGURES 9-11. *Lineus albocinctus* Verrill, 1900. FIG. 9. Antero-dorsal view of preserved worm. FIG. 10. Antero-ventral view of preserved worm. FIG. 11. Dorsal view of posterior part of body. FIG. 12. *Cerebratulus leucopsis* Coe, 1902. Antero-lateral view of preserved worm. FIGURES 13-14. *Nemertopsis bivittata* (Chiaje, 1841). FIG. 13. Two central stylets and bases. FIG. 14. Antero-dorsal view of living worm. FIGURES 15-16. *Emplectonema osceolai*, new species. FIG. 15. Central stylet and base. FIG. 16. Total view of preserved worm.

LETTERING

b—base, c—central stylet, e—eyes, l—longitudinal cephalic slit, m—mouth, t—transverse cephalic furrow.

the transverse cephalic furrow. A frontal sense organ seems to be absent.

Discussion. The only species of the genus known from the Western Atlantic is *E. giganteum* (Verrill, 1873) (Coe, 1943, p. 260). It differs from *osceolai* by its larger size, from 2 to 3.5 m in length and 4 to 8 mm in width; by its bright orange or deep salmon color of the dorsal and flesh color of the ventral side; the presence of a shallow pair of longitudinal cephalic grooves; and 4 pouches of accessory stylets.

Remarks. I have given the species the name *osceolai* in reference to the Indian chief Osceola, famous in Florida history.

Nemertopsis Bürger, 1895 (Friedrich, 1955)

Long, filiform Nemerteans, similar to *Cephalothrix*; four small eyes; cephalic glands very large, reaching beyond the brain backwards; rhynchodaeum opening into the esophagus, caecum short, simple, without pouches directed forward, also lateral pouches are absent (?); rhynchocoel short or $1/3$ length of body; base of central stylet divided into 5 branches as in *Prosorochmus claparedei*; lateral nerve cord with one nucleus of fibers; cerebral sense organs small far in front of brain.

Based upon the type of the genus, *Nemertopsis bivittata* (Chiaje, 1841) from the Gulf of Naples. In order to prepare a definitive diagnosis of *Nemertopsis*, I added (Corrêa, 1955, p. 72) some more characteristics to its diagnosis. They are: the feeble development of the pre-cerebral, dorso-ventral muscles; muscular layers reach tip of head; proboscidal septum of the closed type; dorsal blood vessel originated from the left blood vessel.

An opening of the esophagus into the rhynchodaeum indicated by Friedrich is not typical for *Nemertopsis* (Wijnhoff 1942, p. 123, 182, 185), nor does it occur in *N. bivittata*.

Nemertopsis bivittata (Chiaje, 1841)

Figures 13-14

References. Bürger, 1895, p. 549 pl. 2 figs. 10, 13 pl. 8 figs. 9, 22, 22a pl. 9 fig. 16 pl. 15 figs. 1-5 pl. 27 fig. 15 (short description); 1904, p. 26 (short diagnosis); Corrêa, 1955, p. 72-76 pl. 3 figs. 7-9 pl. 4 figs. 10-12 (full description).

Material. Several worms in winter 1958/59. It is the most abundant species of Nemerteans in shallow water of the Miami area.

Further occurrence. Mediterranean Sea (France and Italy), coast of São Paulo, Brazil.

Description. The living filiform worms (Fig. 14) are up to 15 cm long and 0.2 mm broad. The head is wider than the rest of the body during normal gliding. The ground color is yellowish-white with two dorso-lateral brown stripes, extending almost from tip to tip, but not fusing together anteriorly. The width of the stripes is very variable, and in some worms with wider stripes they can fuse together along the posterior half of the body. Sometimes the stripes cover the whole back leaving only a narrow dorso-median white line with some brown spots in it. The wider stripes show a recess behind the posterior eyes. The brown color can be lighter posteriorly, and some specimens have stripes so light that the worms seem to be uniformly yellowish to the naked eye. There are four eyes (e) situated in front of the shallow transverse cephalic furrow (t).

The enormously developed cephalic glands open anteriorly around the frontal sense organ. They fill all the spaces left by the principal organs of the anterior tip as esophagus, brain, and cerebral sense organs. The cephalic glands reach the posterior level of the stomach.

The broad esophagus opens on the anterior tip ventrally to the frontal sense organ. The large stomach is lined by a villous and ciliated epithelium, rich in erithrophilous glands. There is a long, median ventral caecum underneath the stomach without any antero-lateral pouches. The caecum is about 1 mm long and the space between its ectal tip and the brain measures about 200 μ . It is not as long as it was described by Bürger (1895, p. 549), nor as short as Coe (1904, p. 144) described it in *N. gracilis* Coe, 1904. The gut presents numerous diverticula in its posterior region.

The short rhynchodaeum opens into the oesophagus. The proboscidal septum belongs to the closed type. The rhynchocoel wall is composed of a flat epithelium, a layer of longitudinal muscles and a larger layer of circular muscles. The wall of the anterior chamber of the proboscis consists of an external high epithelium, a thin layer of circular muscles, a thicker layer of longitudinal muscles and the flat internal epithelium. The proboscidal nerves though not distinct seem to be 8 in number. The base (Fig. 13, b) is variable, cylindrical or pear-shaped, but always almost twice as long as the stylet itself. (c).

The sexes are separated. The testes are located outside the intestinal diverticula, and the ovaries alternate with them.

Discussion. The first species described as *Nemertopsis* was *Nemertes peronea* Quatrefages, 1846, later recognized (Bürger, 1904, p. 26)

as a synonym of *Polia bivittata* Chiaje, 1841. Hence the type of the genus is *Nemertopsis bivittata* (Chiaje, 1841).

The genus includes two species and one variety with longitudinal brown stripes, respectively *bivittata*, *gracilis* Coe, 1904 and *gracilis*, var. *bullocki* Coe, 1940. As Coe (1904, p. 142) said, *bivittata* and *gracilis* bear a close external resemblance. They differ only by some feeble characteristics as shape of the base of the stylet and length of the intestinal caecum.

I compared all descriptions of both species with my worms from Naples and from Miami and decided to call my Floridian worms *bivittata*. As I do not have worms of *gracilis* I can not judge the validity of Coe's species from his short description. The shape of the base is variable and should not be taken as important systematic character. The length of the caecum is also variable. It is about the same in *bivittata* from Naples and *bivittata* from Florida but longer than in *gracilis* and shorter than in Bürger's *bivittata*.

The variability of the brown stripes, characteristic of var. *bullocki*, occurs also in my Floridian worms and should not have been used as distinguishing feature.

Ototyphlonemertes Diesing, 1863 (Friedrich 1955)

Slender, filiform Nemerteans; eyes lacking; tip of head with circular and longitudinal muscles; mouth and proboscis pore coincide; caecum short or lacking; pouches of median gut shallow; rhynchocoel about half of body length, its wall normal; dorsal ganglia strongly developed; cerebral sense organs lacking or small, close in front of brain; lateral nerve cords with one fiber nucleus; with one or two pairs of statocysts on the ventral ganglia. The absence of a caecum combined with the post-cerebral glands in several Brazilian species might afford a sub-generic character (Corrêa, 1950).

Ototyphlonemertes pellucida Coe, 1943

Figures 18, 22

References. Coe, 1943, p. 266-268 textfig. 62a-d (full description).

Material. Several worms in winter 1958/59.

Further occurrence. New England coast South of Cape Cod.

Description. Living mature worms reach 10-12 mm in length and 0.2 mm in diameter. The color is uniformly whitish. There is a pair of

highly refractive spherical statocysts (Fig. 22, r) situated in the dorsal surface of the ventral ganglia. They bear one spherical statolith (n) composed of about 8, 12 or 16 transparent globules compactly united. The narrow proboscis has a long canal (Fig. 18, 1) instead of a bulbous chamber. The central stylet is about as long as the slender, cylindrical base. All stylets, central and accessory ones, are marked by spiral grooves.

Ototyphlonemertes evelinae Corrêa, 1948

Figure 20

References. Corrêa, 1948, p. 2-5 pl. 1 figs. 1-7 (full description); 1949, p. 1-7 pl. 1 fig. 1 (ecology); 1950, p. 213-217 (key and comparative morphology); 1953, p. 551 (key); 1954, p. 36 (key).

Material. Several worms in winter 1958/59.

Further occurrence. Coast of São Paulo, Brazil.

Description. The living mature worms attain 30 mm in length and 0.3 mm in width. The color is whitish. As a rule one pair of statocysts (Fig. 20, r) with a longer diameter of about 0.02 mm occurs. Their shape is ovoid with the pointed pole directed inwards in compressed worms; in free swimming ones the statocysts are more or less spherical. They lie in the posterior region of the brain on the dorsal surface of the ventral ganglia. Exceptionally the statocysts may be duplicated on one or both sides. The statolith does not fill the cavity. It lies somewhat excentrically in the statocyst, towards the median line of the body. The statolith in most cases is composed of two globules (n). As already observed in Brazilian specimens of *evelinae*, the Florida worms show a tendency to increase the number of globules in the statoliths. Statoliths with three or many, until nine globules, of different sizes and symmetrically or only on one side are rather common. The base of the central stylet is short, only twice as long as broad at its widest level. The central stylet is smooth and shorter than the base.

Ototyphlonemertes fila Corrêa, 1953

References. Corrêa, 1953, p. 549-551 textfigs. 1, 3, 5, 7 (full description); 1954, p. 36-37 (key).

Material. Several worms in winter 1958/59.

Further occurrence. Coast of São Paulo, Brazil.

Description. The living mature worms are up to 20 mm long and 0.3 mm wide. The color is milky white. There is a pair of spherical statocysts situated on the posterior surface of the ventral ganglia. The statolith is composed of several roundish globules. The base of the

stylet is irregularly cylindrical and as long as the central stylet, which has spiral grooves as the accessory stylets too.

Ototyphlonemertes lactea Corrêa, 1954

Figures 17, 19

References. Corrêa, 1954, p. 34-36 pl. 7 figs. 30-32 (full description).

Material. Several worms in winter 1958/59.

Further occurrence. Paquetá Island, Guanabara Bay, Rio de Janeiro, Brazil.

Description. The living mature worms are 4.5 mm long and 0.1 mm wide. The species is the smallest known within the genus. The color is whitish. The spherical statocysts bear one statolith composed of several spherical globules. The base of the stylet is pear-shaped (Fig. 19, b), and the central stylet (c) whose length is equal to that of the base is marked by spiral grooves.

KEY FOR THE WESTERN ATLANTIC SPECIES OF *Ototyphlonemertes*

The following key uses only easily visible characters of these whitish, small, transparent, sand-dwellers. They are all haptic animals (Remane 1933, p. 185), attaching themselves to sand grains by means of caudal plates or with spiral coiling and so react against external stimuli.

- 1—Statolith composed of two globules (Fig. 20, n) . . . *O. evelinae* Corrêa, 1948
Statolith composed of more than two globules 2
- 2—Statolith composed of three globules (Fig. 21, n) . . . *O. erneba* Corrêa, 1950
Statolith composed of more than three globules (Fig. 22, n) 3
- 3—Central stylet smooth, without spiral grooves *O. brevis* Corrêa, 1948
Central stylet with spiral grooves (Fig. 19, c) 4
- 4—Vesicle of proboscis substituted by a long canal (Fig. 18, l)
O. pellucida Coe, 1943
Proboscoidal vesicle bulbar (Fig. 17, v) 5
- 5—Base of stylet cylindrical *O. fila* Corrêa, 1953
Base not cylindrical (Fig. 19, b) 6
- 6—Posterior chamber of proboscis very short
(Fig. 17, p) *O. lactea* Corrêa, 1954
Posterior chamber of proboscis long *O. parmula* Corrêa, 1950

Oerstedtia Quartrefages, 1846 (Friedrich, 1955)

Small, more or less cylindrical rigid Nemerteans with four eyes; generally with gliding sole; without cephalic furrows; tip of head without longitudinal muscles in the cutaneous-muscular tube; dorso-ventral muscles lacking; cephalic glands large, ventral, reaching beyond brain; esophagus lacking, stomach opens directly into rhynchodaeum; caecum with pouches directed forward; pouches of median gut dorsal; rhynchocoel simple, as long as body; pre-cerebral septum dissolved

into fastening muscles; dorsal vessel without connection with rhynchocoel; cerebral anastomose lacking; lateral nerve cords with two fiber cores; cerebral sense organ small, simple, far anteriorly in tip of head; gonads distributed around the gut.

O. dorsalis, the type of the genus, has two long antero-lateral caecal pouches reaching the most anterior level of the brain anteriorly. The same was stated by Wijnhoff (1930, p. 231 pl. 9 f. 14). The contrary record of Friedrich (1955) may be due to his overlooking of Wijnhoff's paper.

In her comparison between *Oerstedtia* and *Tetrastemma*, Wijnhoff (1930, p. 237) considers the first genus as more primitive than the second. Her reasons are: 1) the simple construction of the brain and the presence of a dorsal strand of fibers in the lateral nerve cords; 2) the absence of an esophagus; 3) the simple structure of the blood system; 4) the primitive disposition of the gonads; 5) the simple anatomy of the cerebral sense organs.

Oerstedtia dorsalis (Abildgaard, 1806)

References. McIntosh, 1873, p. 172-174 pl. 1 fig. 4 pl. 3 fig. 4 (short description); Verrill, 1892, p. 409 pl. 34 figs. 13-14 (short description); Bürger, 1895, p. 592-593 pls. 3 figs. 27, 29, 30, 34-34a, 35-36 pl. 18 fig. 22 pl. 26 figs. 52-53 pl. 29 figs. 33-35 (short description); Coe, 1904, p. 169-170 (short description); 1905, p. 299-300 pl. 2 fig. 19 (short description); 1940, p. 294 (habitat and distribution); 1943, p. 268-269 textfig. 40 (short description); 1951, p. 329 (distribution); 1951a, p. 170 (short description); Wijnhoff, 1930, p. 226-240 pl. 7 figs. 1-10 pl. 8 figs. 11-13 pl. 9 figs. 14-16 (monograph).

Material. Several worms in winter 1958/59.

Further occurrence. Coasts of Europe and Madeira; from Nova Scotia to Northern Florida; in the Gulf westward to Texas; from Puget Sound to Mexico.

Description. The living worms are up to 15 mm long and 0.3 mm broad. The color is light cream irregularly spotted with brown of various shades and with considerable variations in shape and distribution. The cylindrical body tapers towards both extremities. There are two pairs of eyes but no cephalic furrows.

The epidermis is high and rich in glands. The basement membrane is thicker than the subjacent circular muscular layer. The longitudinal muscular layer is weak and completely absent on the tip of the head. The first longitudinal fibers appear at the level of the proboscicial septum. Dorso-ventral muscles are absent. The cephalic glands are enormously developed and distributed all around the rhynchodaeum. Backwards they reach the posterior level of the brain.

An esophagus is absent. The stomach or anterior part of the gut is rich in glands and opens into the rhynchodaeum. The mid gut has a median-ventral caecum under the stomach and two long antero-lateral pouches which attain the anterior border of the brain as already described and drawn by Wijnhoff (1930, p. 231-232, pl. 9, f. 14). The gut has also lateral diverticula.

The rhynchodaeum is muscular and opens subterminally. The proboscoidal septum is strong but of the open type. The wall of the anterior proboscoidal chamber is composed of a high external epithelium, a thin layer of circular muscles, a thicker layer of longitudinal muscles and the flat internal epithelium. There are 10 proboscoidal nerves. The central stylet is as long as the cylindrical base. A band of diaphragmatic glands is disposed at the median level of the base. There are two accessory stylets in each of the two pouches.

The two pre-cerebral blood vessels have an anterior commissure. Behind the brain there are two lateral vessels and a dorsal one situated between the rhynchocoel and the gut. A rhynchocoel vessel is absent.

The nephridial ducts appear at the level of the stomach. They are strongly developed.

The brain is small and without any external subdivision into ganglia. On its posterior border the fiber nucleus of the dorsal ganglia is divided into a dorsal and a ventral one. The ventral core of the dorsal ganglia together with that of the ventral ones enters into the lateral nerve cords which have two bundles of fibers. The two ganglia of each side are connected by a thin ventral commissure and a thick and long dorsal commissure.

The cerebral sense organs are small, egg-shaped, and situated far anteriorly among the cephalic glands. As transverse cephalic furrows are absent, the short and ciliated cerebral canals open into a small epidermic pore on the anterior tip of the head. Even in living animals I did not succeed in seeing the frontal sense organ (Wijnhoff, 1930, p. 231).

The gonads are round pouches situated dorsally and ventrally to the lateral nerve cords. They alternate with the intestinal diverticula.

Zygonemertes Montgomery, 1897 (Friedrich, 1955)

Many eyes extended backwards beyond the brain, over and beside the lateral nerve cord, and, specially behind the brain, more or less serially disposed; anterior part of body with numerous sub-epithelial

glands (?); esophagus opens into rhynchodaeum; median gut without unpaired caecum directed forwards, substituted by two long paired pouches (evidently in *Z. capensis* Wheeler, 1934 and *Z. glandulosa* Yamaoka, 1940, with caecum); rhynchocoel reaching the posterior end, its wall double-layered; proboscis thick and short, anterior part of it with only one layer of circular muscles; base of central stylet long, cylindrical, posteriorly truncate, in front of the posterior end generally with an annular furrow; lateral nerve cords with one fiber nucleus; anal commissure dorsal to gut; cerebral sense organs large, immediately in front of or near the brain (?), clearly separated from it.

The presence of a caecum in *Z. capensis* is not clearly stated by Wheeler (1934, p. 241): "on each side appears a branch of the anterior caecum." I understand that the author described what I call the antero-lateral pouches. *Z. glandulosa* Yamaoka, 1940, really seems to possess a caecum under the pylorus (Yamaoka 1940, p. 246, f. 24 a-b, ic). According to Böhmig (1929, p. 16-17 f. 19-20) and Friedrich (1936, p. 14 f. 3) an intestinal caecum is a median-ventral projection of the gut, from which, if present, the antero-lateral pouches emerge.

The five species of *Zygonemertes* that I have seen, *virescens* (Verrill, 1879), *fragariae* Corrêa, 1954, *isabellae* Corrêa, 1954, *simoneae*, n. sp., and *cocacola*, n. sp., show a point where the two antero-lateral intestinal pouches are joined under the posterior region of the stomach. I do not call this confluence a median caecum because it is only a point of union, not an independent projection of the gut.

The extension of the cerebral sense organs varies. It is difficult to judge the size of the various organs without knowing their exact measurements and their proportion to length of the worm. In *fragariae* the cerebral organs are small; in the much smaller *isabellae*, relatively large.

Zygonemertes virescens (Verrill, 1879)

References. Verrill, 1892, p. 400 pl. 33 figs. 4a-4e (short description); Montgomery, 1897, p. 2-4 pl. 1 figs. 14-15, 23-24, 28 (almost full description); Coe 1905, p. 214-216 pl. 22 figs. 141-144 (almost full description); 1940, p. 295-296 pl. 30 fig. 39 (short description); 1943, p. 270-273 textfigs. 63-54 (almost full description); 1951, p. 329 (geographical distribution); 1951a, p. 170-171 textfig. 16a-e (short description).

Material. Several worms in winter 1958/59.

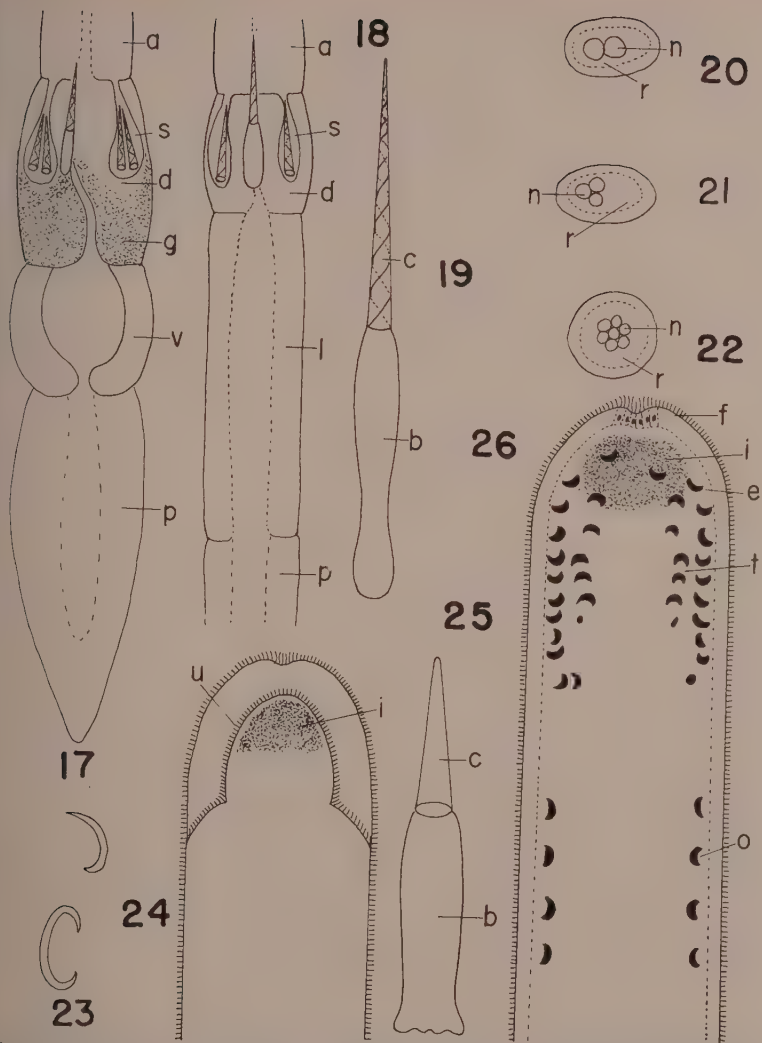
Further occurrence. From Bay of Fundy to Northern Florida and along the Gulf coast at least as far as Pensacola, Fla. From British Columbia to Mexico on the Pacific coast.

Description. The living mature, restless, and highly contractile animals attain 3 cm in length and 1 mm in maximum width. The color, as usually in this species, changes from white to yellow and green. There are numerous pre-cerebral eyes disposed in irregular lateral rows along the entire length of the head and extended backwards for a certain distance beyond the brain in a single row along each lateral nerve cord. Adult worms have many more eyes than in the young stages.

The large rhynchodaeal pore leads to a very narrow rhynchodaeum compressed dorsally and ventrally by the extremely large cephalic glands. At the level of the cerebral sense organs the cephalic glands become smaller and consequently the rhynchodaeum is larger, with a high epithelium and a thick coat of muscles. The proboscidal septum belongs to the closed type. Its muscular bundles are thick, inserted all around the insertion zone of the proboscis and distinctly connected with the body musculature. The rhynchocoel reaches the posterior tip of the body and is much longer than the proboscis. At the cerebral level the rhynchocoel is very narrow and high. The rhynchocoel wall is composed of a rhynchocoelic epithelium, a thick layer of longitudinal muscles and a layer of circular muscles. The wall of the anterior chamber of the proboscis is composed of a high and glandular external epithelium, a layer of external circular muscles, a layer of longitudinal muscles in which the ten longitudinal nerves are situated, a thinner layer of longitudinal muscles, a thin layer of internal circular muscles and the flat internal epithelium. There are two nerve plexus, one between the external circular layer of muscles and the thick layer of longitudinal muscles and the other between the two layers of longitudinal muscles. The central stylet is shorter than its base which is truncate and posteriorly lobate. Each pouch of accessory stylets has two stylets of the same kind.

Discussion. The genus *Zygonemertes* includes eleven known species: *virescens* (Verrill, 1879) from the Eastern North Pacific and Western North Atlantic, *thalassina* Coe, 1904, and *albida* Coe, 1904, both from the Eastern North Pacific, *luderitzi* Wijnhoff, 1916, *africana* Wijnhoff, 1916, and *capensis* Wheeler, 1934, from the Eastern South Atlantic, *glandulosa* Yamaoka, 1940, from the Western North Pacific, *fragariae* Corrêa, 1954, and *isabellae*, Corrêa, 1954, from the Western South Atlantic, and the new species *simoneae*, and *cocacola*, described in the following from the Western North Atlantic.

The genus is quite uniform in its features. Besides the size and color



FIGURES 17-22. *Ototyphlonemertes* Diesing, 1863. FIG. 17. Short proboscis with typical bulbous vesicle (*O. lactea* Corrêa, 1954). FIG. 18. Long proboscis with proboscis canal (*O. pellucida* Coe, 1943). FIG. 19. Central stylet with spiral grooves and base (*O. lactea* Corrêa, 1954). FIG. 20. Statolith with two globules (*O. evelinae* Corrêa, 1948). FIG. 21. Statolith with three globules (*O. erneba* Corrêa, 1950). FIG. 22. Statolith with several globules (*O. pellucida* Coe, 1943). FIGURES 23-26. *Zygonemertes simoneae*, new species. FIG. 23. Sickle-shaped bodies. FIG. 24. Antero-dorsal part of living worm. FIG. 25. Central stylet and base. FIG. 26. Antero-dorsal part of living worm.

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a—anterior proboscis chamber, b—base, c—central stylet, d—diaphragm, e—pre-cerebral external eyes, f—frontal sense organ, g—diaphragmatic glands, i—pigmented cephalic spot, l—proboscis canal, n—statolith, o—post-cerebral eyes, p—posterior proboscis chamber, r—statocyst, s—pouch of accessory stylets, t—pre-cerebral internal eyes, u—transverse cephalic furrow, v—bulbous vesicle.

the best character is the number of proboscicial nerves.

Based on this number I can separate the following species from *virescens*: *isabellae*, *lüderitzi* (11 nerves), *thalassina*, *glandulosa*, *simoneae* (12 nerves) and *capensis* (13 nerves). *Albida* and *africana* whose number of proboscicial nerves is not known differ from *virescens* by smaller size and color.

Virescens, *fragariae*, and *cocacola* have 10 nerves. *Z. virescens* is smaller than *fragariae* (up to 5 cm) and *cocacola* (9 cm) and has different color: *fragariae* is pinkish, and *cocacola* is light brown.

Zygonemertes simoneae, new species

Figures 23-26

Material. Several worms in winter 1958/59.

Type. One set of 12 μ transverse sections (10 slides) under the number M 2 deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, Brazil.

Description. The filiform mature worms attain alive up to 4 cm in length and 0.5 mm in maximum width. During normal gliding the width is uniform throughout the body except the head which is broader than the trunk and separated from it by a constriction. The anterior end is slightly rounded while the posterior can be rounded or pointed. The young worms are white or yellowish-white, the mature ones pinkish. Antero-dorsally there is a pigmented spot (Figs. 24, 26, i), almost black, situated between the first pre-cerebral eyes. Under the microscope the pigment reveals to be formed by a network of fine blue threads. Coe (1943, p. 215) stated: "nearly all the primary colors or combinations of colors are represented among the Nemerteans with the exception of the blue." The blue network is still present after preservation with hot formalin. Between the brain and the pigmented spot there is a diffuse brownish-yellow zone. The only present cephalic furrow (Fig. 24, u) runs first transversely on the back and then forwards curving around the cephalic pigment spot (i). There are eyes before and behind the brain. The pre-cerebral eyes are only few in young stages and disposed in a single row on each side of the head. In adult worms they are more numerous, 30 or even more, distributed in two irregular rows. The outer row (Fig. 26, e) is composed of more eyes than the inner one (t). The eyes of the former have their pigment cups directed to the anterior end of the body while those in the latter are turned backwards. The post-cerebral eyes (o), whose pigment cups are directed laterally, are disposed in a single row of two or three eyes on each side, in both young and adult worms. The eyes lie deeply in the body parenchyma or in the muscle layers.

In living worms flattened between slide and cover-slide, numerous generally sickle-shaped bodies (Fig. 23) appear first described in *Emplectonema echinoderma* (Marion, 1830) (Bürger, 1895, p. 124, 216). At a first glance they seem to be calcareous corpuscles. Probably they are extra-cellular secretions, colorless or pigmented, originated from epidermal cells (Coe, 1943, p. 217). They occur in all species of *Zygonemertes* and, besides *Emplectonema*, also in *Alaonemertes michaelsoni* Wijnhoff (1942, p. 162) and one more species (l. c., p. 123). The sickle shaped bodies can also be seen in clarified animals and in sections, as they do not dissolve in the liquids used for preparation. Besides the ciliated and glandular cells the epidermis contains these sickle-shaped bodies, somewhat variable in form and number. They occur in the superficial and deeper epidermal layers. Subepithelial glands are abundant before the brain. The basement membrane is medium thick. The body musculature reaches the tip of the head, but is not very distinct. Some feeble dorso-ventral fibers occur before the brain. Behind it the longitudinal muscles are broader than the circular ones. The cephalic glands extend from the tip of the head to the anterior border of the brain. They are composed of large and small clusters situated all around the rhynchodaeum.

The esophagus opens into the rhynchodaeum shortly before the brain. Behind the brain it opens into the long stomach whose wall is deeply villous, ciliated and glandular. The gut bears two long antero-lateral pouches, with some diverticula, situated on both sides of the rhynchocoel and dorsally to the lateral nerve cords. The antero-lateral pouches which reach the posterior border of the brain in front have the same tissues as the gut itself. At the posterior level of the stomach and under it both pouches join together. The gut which has several lateral diverticula was filled with intra-cellular particles of digestion. There are numerous erythrophilous glands in the gut epithelium.

The broad rhynchodaeal pore is situated on the anterior tip of the head ventrally to the frontal sense organ. The rhynchodaeal epithelium is high and rich in basophilous glands in its inner part. Shortly before the entrance of the esophagus the rhynchodaeum is encircled by a thick muscular coat whose fibers are connected with the muscular proboscidal septum. The rhynchocoel reaches the posterior end of the body; the proboscis is shorter. Its septum belongs to the closed type composed of several muscular bands around the zone of insertion. The anterior chamber of the proboscis shows the following layers:

high external epithelium, a layer of external circular muscles, thick layer of longitudinal muscles composed of an external layer of thick bundles and an internal layer of thin bundles, a very thin layer of circular muscles and a flat internal epithelium. On the limit between the two layers of longitudinal muscles there are twelve proboscoidal nerves. Branching from each nerve is a dichotomic link which forms a nerve plexus. The quadrangular diaphragm has a large belt of glands around the base (Fig. 25, b) of the thick central stylet (c) which is shorter than its base. The latter is darkly granular, truncate and lobate at the posterior end. The two pouches of accessory stylets each bear one or two stylets. The bulbous vesicle is strongly muscular.

The two pre-cerebral vessels are united by an anterior commissure dorsally to the rhynchodaeum. In life the commissure showed pulsatile vesicles in its wall. At the posterior level of the brain the two anterior vessels unite in a knob from which three posterior vessels originate, two lateral and one dorsal. Shortly behind its beginning, the dorsal vessel sinks into the rhynchocoel wall, loses its lumen, assumes the aspect of a spongy body, and behind this regressive strand reappears, recovers its lumen and its normal position between rhynchocoel and gut. The lateral vessels run backwards internally to the lateral nerve cords and ventrally to them.

The cerebral ganglia are united by a narrow ventral and a thick dorsal commissure both situated at the same level. The fiber nucleus is single on each side at the anterior border of the ganglia. At their median level a stretch of ganglionic cells divides the ganglia into a dorsal and a ventral nucleus on each side. The ventral ganglia give rise to the lateral nerve cords which have only one fiber nucleus. Some of the ganglionic cells are larger and seem to be giant neurochord cells. Their neurochords are seen in transverse sections of the lateral nerve cords. The cerebral sense organs are small and situated somewhat distant from the brain. Their canals lead to the transverse cephalic furrow. The organs consist of a small ciliated chamber with a coat of ganglionic cells. A frontal sense organ is present (Fig. 26, f).

The worms are dioecious. Both ovaries and testes were fully ripe in winter. They are situated dorsally and ventrally to the lateral nerve cords.

Remarks. This species is named in honor of Mrs. Simone Johnston from the staff of The Marine Laboratory, University of Miami, who kindly put the panels for her study of anti-fouling paints at my disposal.

Discussion. *Z. simoneae* differs from the ten other species of the genus by the presence of the cephalic pigmented spot. The other species of *Zygonemertes* with 12 proboscidial nerves are *glandulosa* and *thalassina*, the first smaller than *simoneae* and pale blue, the second olive-green. The two species of the genus whose number of proboscidial nerves is not known, *albida* and *africana*, differ from *simoneae* by much smaller size and the shape of their central stylet.

Zygonemertes cocacola, new species

Figures 27-28

Material. Two worms in January, 1959.

Type. One set of 12 μ transverse sections of the anterior part of the body (7 slides), and the posterior not sectioned part under the number M 3 deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, Brazil.

Description. The living mature worms (Fig. 28) were 9 cm long, 1 mm broad and flattened. The width is uniform except for the head which is broader than the trunk during locomotion. After preservation the animals became mostly cylindrical. The anterior end is rounded and the posterior pointed. The uniform color is light tan. There are numerous pre-cerebral eyes disposed in two irregular rows on each side of the head. The thickness of the worms hindered me to see the posterior eyes and most of the internal details.

The epidermis is normal. The basement membrane is as thick as the circular muscles. The sub-epithelial glands are very numerous before the brain and very rare behind it. The body musculature reaches the tip of the head. A thick muscular net is present in the pre-cerebral region; the dorso-ventral fibers are the strongest. Some post-cerebral dorso-ventral fibers are also present. The cephalic glands have the shape of large clusters dorsal to the rhynchodaeum and smaller ones laterally and ventrally to it. They do not reach the anterior level of the brain.

The esophagus opens into the rhynchodaeum. There are two long antero-lateral intestinal pouches which anteriorly reach the posterior border of the brain. They unite in the median-ventral line under the stomach. Intestinal lateral diverticula are not present in the anterior half of the body.

The large rhynchodaeal pore is situated ventro-laterally. The rhynchodaeal epithelium and its lumen are not distinct in the outermost part of the rhynchodaeum. At the posterior level of the cerebral sense

organs the rhynchodaeum occupies a central position, its glandular epithelium becomes quite distinct, and a thick coat of muscles develops. The extremely strong proboscoidal septum belongs to the closed type and originates from the muscular rhynchodaeal coat which is thinner at that level. The large bundles of septal muscles are clearly connected with the body musculature. The broad rhynchocoel reaches the end of the body. Its thick wall is composed of a rhynchocoelic epithelium facing the rhynchocoel cavity, a layer of longitudinal muscles and a layer of circular muscles both of the same height. The very strong ental wall of the anterior proboscoidal chamber shows the following layers: a high and richly glandular external epithelium, a layer of external circular muscles, a large layer of external longitudinal muscles containing the ten longitudinal nerves, a thinner layer of internal longitudinal muscles, a very thin layer of internal circular muscles and the flat internal epithelium facing the rhynchocoel cavity of the inverted proboscis. The nerves which are triangular in section have branches from which a nervous plexus arises internally to the external circular musculature. A second nervous plexus separates both layers of longitudinal muscles. I could not see the details of the proboscis in living or clarified animals due to the thickness of the body wall. The central stylet (Fig. 27, c) is half the size of its base (b). The bottle-shaped base is truncated posteriorly without distinct lobulation.

There is a pair of very large anterior vessels united almost in the tip of the head by a large commissure. These vessels collapse completely at the brain level, and posteriorly to it there are three vessels, one dorsal and two lateral.

Close behind the brain there are some efferent lateral nephridial ducts, whose vesicles and thin canals with nucleated wall passing through the body musculature were seen.

The brain is composed of a dorsal and a ventral pair of ganglia. They are united by a broad ventral and a narrow dorsal commissure. The lateral nerve cords originated from the ventral ganglia have one fiber nucleus.

The sections showed large full grown testes situated dorsally and ventrally to the nerve cords.

Remarks. This species is named *cocacola* for the well known soft drink which I enjoyed so much during my stay in the United States and which made my daily work so much more refreshing.

Discussion. The other species of *Zygonemertes* with ten longitudinal nerves are: *virescens* and *fragariae*. The first is much smaller than *cocacola*; the second, commonly pinkish in color, reaches a maximum length of 5 cm.

The number of proboscidial nerves is not known in *albida* and *africana*. Both species are much smaller than *cocacola*. Besides the first has a different color, and the latter differs by the shape of base and proportions between central stylet and its base.

Amphiporus Ehrenberg, 1831 (Friedrich, 1955)

Generally large, stout forms; seldom none or 2 or 4 eyes, generally many to very many, distributed in groups; cephalic and sub-epithelial glands present or lacking; cutaneous-muscular tube with or without diagonal layer; dorso-ventral muscles generally present; esophagus opens into rhynchodaeum; caecum with pouches of different length; without diverticula of esophagus, stomach or pylorus; rhynchocoel as long as body; nephridial apparatus probably always limited to a short stretch behind the cerebral ganglia; cerebral sense organs anterior to brain, maximally reaching under its anterior border, sometimes small, in the tip of the head, sometimes larger and nearer to the brain (the *pulcher* group differs essentially in this point).

Amphiporus ochraceus (Verrill, 1873)

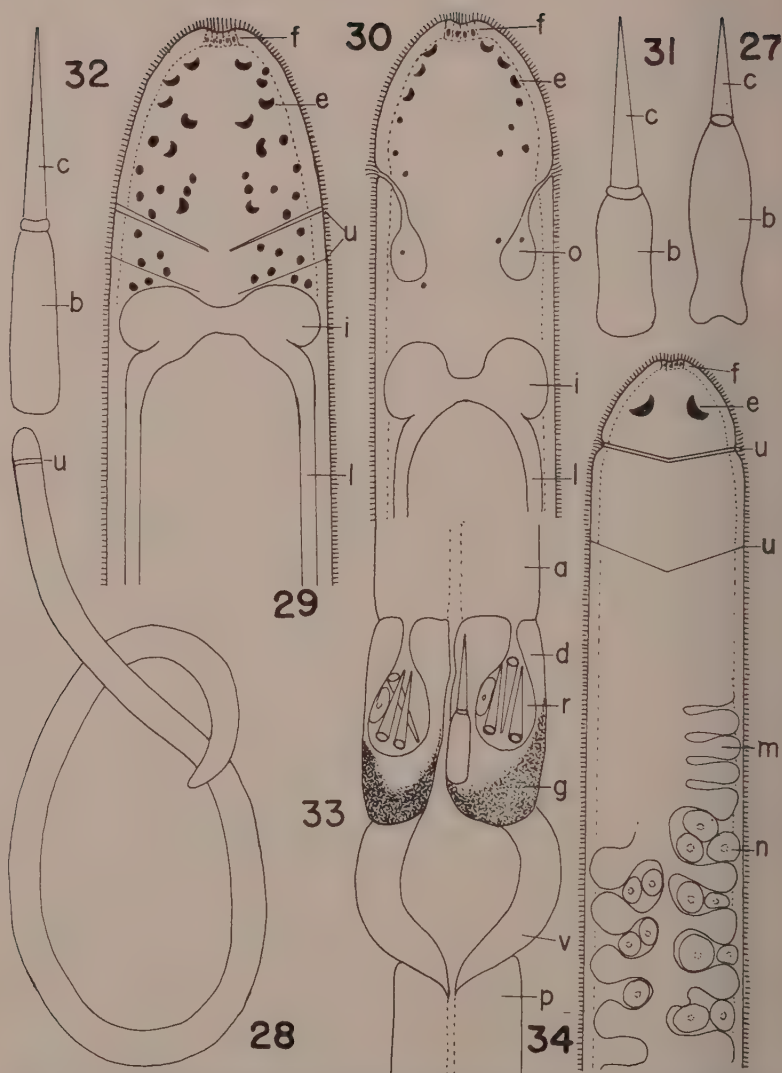
Figure 29

References. Verrill, 1892, p. 396-397 pl. 33 figs. 5-6 pl. 39 fig. 8 textfig. 8 (short description); Montgomery 1897, p. 6-8 pl. 1 figs. 1-11, 17 (short description); Coe, 1943, p. 285-287 textfig. 70 a-c (short description); 1951, p. 329 (distribution); 1951a, p. 172-173 textfigs. 18 a-c (short description).

Material. Several worms in winter 1958/59.

Further occurrence. Massachusetts Bay to Florida and on the Gulf coast westward to Port Aransas, Texas.

Description. The largest mature worm was a female, 3 cm long and 0.3 mm in maximum width. The head is wider than the first third of the trunk, but the biggest width is in the middle of the body. The anterior end is rounded and the posterior tapers gradually to a pointed tail. The uniform color is yellowish-white to light brown. The worms are highly contractile; a 3 cm long worm can diminish its length to 1 cm. There are two transverse cephalic furrows (Fig. 29, u). Into the anterior furrow opens the canal from the cerebral sense organs. The posterior furrow lies at the anterior level of the brain (i). One mature worm has about 26 eyes (e) on each side of the head distributed in irregular rows.



FIGURES 27-28. *Zygonemertes cocacola*, new species. FIG. 27. Central stylet and base. FIG. 28. Total view of preserved worm. FIG. 29. *Amphiropus ochraceus* (Verrill, 1873). Antero-dorsal view of living worm. FIGURES 30-31. *Amphiropus texanus* Coe, 1951. FIG. 30. Antero-dorsal view of living worm. FIG. 31. Central stylet and base. FIGURES 32-34. *Tetrastemma bobi*, new species. FIG. 32. Central stylet and base. FIG. 33. Stylet region of proboscis. FIG. 34. Antero-dorsal view of living worm.

LETTERING

a—anterior proboscis chamber, b—base, c—central stylet, d—diaphragm, e—eyes, f—frontal sense organ, g—diaphragmatic glands, i—brain, l—lateral nerve cord, m—intestinal diverticles, n—ovary, o—cerebral sense organ, p—posterior proboscis chamber, r—accessory stylets, u—transverse cephalic furrow, v—bulbous vesicle.

The cephalic glands are not very large and only reach the foremost border of the brain.

The gut has a long caecum under the stomach and two antero-lateral pouches with diverticula. Also the posterior gut has lateral diverticula.

The esophagus opens into the rhynchodaeum. The rhynchocoel is long and the proboscis very strong. The rhynchocoel wall is composed of a flat epithelium and layer of muscles, an external longitudinal and an internal circular. At the level of the anterior chamber the proboscis wall is composed of a high external epithelium, a thin layer of circular muscles, a thick layer of longitudinal muscles and the flat internal epithelium. There are 11 proboscidial longitudinal nerves situated in the longitudinal muscular layer. The proboscidial septum is not completely closed, as it lacks some fibers to be complete. The base of the central stylet is pear-shaped and almost as long as the stylet. The glands of the diaphragm appear as a band on both sides of the central stylet. Normally there are two pouches each with 2 or 3 accessory stylets. Exceptionally there are 3 pouches of accessory stylets.

There is a frontal sense organ (f). The cerebral sense organs are large and reach the anterior border of the brain.

The gonads alternate with the intestinal diverticula.

Amphiporus texanus Coe, 1951

Figures 30-31

References. Coe, 1951, p. 329 textfig. 1 (short description); 1951a, p. 173-174 textfig. 19a-b (the same description as 1951).

Material. Several worms in winter 1958/59.

Further occurrence. Port Aransas, Texas.

Description. The largest mature worm was 8 cm long and 0.5 mm in maximum width. Most of the specimens measured from 2.5 to 6 cm in length. In normal gliding the head may be wider or narrower than the trunk. Both ends are rounded. On the posterior end the epidermis is higher than on the trunk and acts as a fixing caudal plate which is distinct also in worms not under a cover slide. The color is uniformly brown except the anterior, posterior and lateral borders which are colorless. Antero and antero-laterally the colorless borders are wider than in the rest of the body. There is one incomplete cephalic transverse furrow. It seems to be the outlet of the canal of the cerebral sense organs (Fig. 30, o), which is bordered by long cilia. There are few

about 10 eyes (e), distributed in two irregular rows on each side of the head, just on the antero-lateral borders of the brown pigment. This position of the eyes makes it difficult to count them. Their color is quite like the ground color. Some specimens showed also irregular small eyes scattered on the head to the level of the cerebral sense organs (o).

The muscular layers reach the tip of the head. There is a thick muscular net in the pre-cerebral region around the lobules of the enormously developed cephalic glands. These extend all around the rhynchodaeum and reach as far posteriorly as the hindmost level of the brain. Behind and before the brain there are thick bundles of dorso-ventral muscles.

The esophagus opens into the rhynchodaeum. There is a very short median-ventral caecum under the stomach without lateral pouches.

The rhynchodaeal pore is very large and situated sub-terminally anteriorly to the frontal sense organ. The rhynchodaeal wall is very thin in its outer region and highly muscular at the level of the proboscidal septum. The latter is very strong, mostly at the sides and of closed type. The rhynchocoel is almost as long as the body. Its wall is composed of a flat epithelium, a thick layer of longitudinal muscles and an also thick layer of circular muscles. The thickness of the muscular layers is variable along the length of the rhynchocoel. The anterior proboscidal chamber wall is composed of a high external epithelium, a thin layer of circular muscles, a very thick layer of longitudinal muscles and the flat internal epithelium. The central stylet (Fig. 31, c) is much longer than its base (b) whose shape in most of the specimens was broad pear-shaped. Only a few worms showed a rectangular base as drawn by Coe (1951, p. 329 f. 1; 1951a, p. 173 f. 19). Each pouch of accessory stylets has 2 to 3 stylets as long as the central one.

The most striking feature in the sections is the enormously developed nephridial system. On both sides, from shortly behind the brain to the posterior level of the stomach there are many ductules dorsally to the lateral nerve cords.

A frontal sense organ is present (Fig. 30, f). The cerebral sense organs (o) are large, complex, with accessory chambers and situated far anteriorly to the brain (i).

Discussion. My worms show some differences from Coe's specimen, for instance the shape of the base and the proportion of the length of

the central stylet to its base. Evidently this character is somewhat variable. My worms surely belong to Coe's species, whose occurrence on the Southern Atlantic coast of the United States had been predicted by Coe (1951, p. 329).

Prostomatella Friedrich, 1935 (Friedrich, 1955)

Small *Tetrastemma*-like nemerteans with four eyes; circular and longitudinal muscles reaching the tip of the head; dorso-ventral muscles very little developed; cephalic glands small, not reaching the brain; esophagus opens into rhynchodaeum; caecum simple without pouches directed forward; diverticula of median gut flat; rhynchocoel simple, extended to end of body; pre-cerebral septum dissolved into fastening fibers; nephridium short, on either side with several pores; lateral nerve cords with one fiber nucleus; cerebral sense organ attaining border of brain.

Probably the genus includes more than the two species described by Friedrich (1935, p. 340) and the already known species from Brazil, *P. enteroplecta* Corrêa, 1954 and *P. merula* Corrêa, 1954. The pre-cerebral proboscidal septum is dissolved into isolated fastening muscles in *Prostomatella* and of the closed type in *Tetrastemma*, was not described in most of the species of *Tetrastemma*.

P. enteroplecta and *P. merula* show, besides the median ventral caecum of the gut, also two antero-lateral intestinal pouches directed forward, and cephalic glands extending at least to the median level of the brain.

Prostomatella enteroplecta Corrêa, 1954

References. Corrêa 1954, p. 54-59 pl. 11 figs. 57-61 pl. 12 fig. 62 (full description).

Material. Several worms in winter 1958/59.

Further occurrence. Coast of São Paulo, Brazil.

Description. The living mature and flattened worms reach 30 mm in length and 0.6 mm in maximum width. The width decreases towards the ends. The anterior tip is truncate and shows in front the frontal sense organ and under it the rhynchodaeal pore. The posterior end is filiform and pointed. The uniform color is whitish or light yellow. There are two pairs of eyes. The anterior pair is black, large, situated close to the anterior tip and has a band of brown pigment between its two pigment cups. The posterior pair of eyes is smaller, roundish, reddish, and lies behind the anterior cephalic furrow. The posterior

furrow, less distinct than the anterior one, is located at the level of the cerebral sense organs whose canal leads to the anterior furrow.

The wall of the rhynchocoel is composed of a flat epithelium, a layer of longitudinal muscles, and a layer of circular muscles. The wall of the anterior proboscoidal chamber is composed of a high external epithelium, a thick layer of circular muscles, a large double layer of longitudinal muscles, thicker external and thinner internal ones, containing a dense fiber net, an internal thin layer of circular muscles and the flat internal epithelium, poor in nuclei. The ten proboscoidal nerves are situated in the longitudinal layer and are enveloped by the fibers of the fiber net. The central stylet is almost as long as its pear-shaped or cylindrical base. The two pouches of accessory stylets have each 1-2 stylets.

Discussion. *P. arenicola* Friedrich 1935, p. 340 has only a median intestinal caecum without antero-lateral pouches in opposition to *enteroplecta* with two long antero-lateral intestinal pouches. The type species of *Prostomatella*, *P. vermiculus* (Quatrefages, 1846), vastly distributed in European waters, the middle Atlantic Ocean (Madeira), and on the North American coast (Coe, 1943, p. 294), has a longitudinal pigment band between the eyes of each side (Bürger 1895, t. 3 f. 17, 18) not the transverse band between the anterior eyes. *P. merula* Corrêa, 1954 differs by its black or variously shaded dark brown color from the three other species of the genus.

Prostomatella merula Corrêa, 1954

References. Corrêa, 1954, p. 59-62 pl. 12 figs. 63-66 (full description).

Material. Several worms in winter 1958/59.

Further occurrence. Coast of São Paulo, Brazil.

Description. The living mature worms were 10-12 mm long and 0.5 mm broad in the middle of the body; the anterior and posterior regions are much narrower. The anterior end is truncate, the posterior pointed. The ground color is dirty white with variable light brown, dark brown or almost black stripes. The Brazilian specimens already showed this variability of pigmentation whose range is much ampler in the Floridan worms. I could establish the following principal types: 1) A large, almost black median-dorsal stripe, sometimes well delimited at its borders, which generally do not attain the posterior and lateral margins of the body. The band is pointed posteriorly and anteriorly split in two branches which reach the anterior eyes and sometimes even farther

forwards. Around the posterior eyes there is often an unpigmented zone. Type 1 is the most common both in Brazil and Florida. 2) A median-dorsal brown stripe without regular borders and brown spots situated externally to the median stripe which is narrower than in Type 1. The median-dorsal stripe splits anteriorly its branches reaching the anterior eyes and passing between or over the posterior eyes. 3) A very narrow dorso-median brown stripe, irregularly delimited against the ground color, sends a pair of branches between the eyes. 4) Two large dorso-lateral brown stripes with irregular borders, separated in the median line by an unpigmented line which has some brown spots. From each stripe one branch goes to the anterior eye of the same side. 5) Two narrow dorso-lateral brown stripes from which a branch is sent to each of the anterior eyes. 6) Without stripes and irregularly spotted with brown. Some spots occur between the eyes too.

The first pair of eyes is situated anteriorly to the anterior cephalic transverse furrow, and in sections it is shown lying in the body parenchyma to the sides of the cephalic glands. The smaller posterior eyes are situated in front of the posterior cephalic transverse furrow and in sections at the level of the proboscidal septum.

Discussion. The species differs by its color types from the other species of the genus which are lighter and do not have so defined patterns. As the proboscidal septum is not known in most of the species of *Tetrastemma* I have to compare *merula* with the dark colored species occurring on the South and Central American Atlantic coasts. These are: *duboisii* Bürger, 1893, only 5 mm long and without long antero-lateral intestinal pouches, and *antarcticum* Bürger, 1893, whose short diagnosis without any figure does not contain details which would make a comparison possible.

Tetrastemma Ehrenberg, 1831 (Friedrich, 1955)

Generally small, slender nemerteans; tip of head with circular and longitudinal muscles as well as retractors; cephalic glands present, very variable in size, sometimes reaching far beyond brain; esophagus opens into rhynchodaeum; caecum of median gut present, with lateral pouches and two more pouches directed forward; pouches of median gut shallow, generally not branched; rhynchocoel as long as body (except *T. hansii* Bürger, 1893), without diverticula; precerebral septum (as far as known) closed; nephridia short, generally with one or two pores; lateral nerve cords with one fiber nucleus; cerebral sense organs generally large, situated in front of brain. exceptionally in cerebral

region; generally dioecious (except *T. marioni* Joubin, 1890 and *T. caecum* Coe, 1901).

Tetrastemma candidum (Müller, 1774)

References. McIntosh, 1873, p. 167-169 pl. 2 figs. 2-3 (short description); Verrill, 1892, p. 404-406 pl. 33 figs. 9-10a pl. figs. 9-10 (short description); Bürger, 1895, p. 586 pl. 3 figs. 13, 19 pl. 29 figs. 53-54 (short description); 1904, p. 64 (short description); Stephenson, 1913, p. 19-23 pl. 48 fig. 15 (short description); Wheeler, 1934, p. 243-244 pl. 15 fig. 15 (short description); Coe, 1940, p. 305 (habitat and distribution); 1943, p. 292-293 textfig. 73 a-c (short description); 1951, p. 329 (distribution); 1951a, p. 175 textfig. 20 a-c (short description).

Material. Nine worms in winter 1958/59.

Further occurrence. From Labrador to Northern Florida and along the Gulf coast at least as far west as Louisiana; European coasts; Madeira and South Africa; on the Pacific coast from Alaska to Mexico.

Description. The mature, restless worms are 15 to 20 mm long and about 1 mm broad. After preservation they measured respectively 10 and 0.6 mm and are somewhat narrowed behind the spatulate head. The anterior and posterior ends are slightly pointed. The uniform color is whitish or pinkish-white. They present two transverse cephalic furrows. The anterior, dorsally incomplete one, is situated at the level of the posterior eyes, and the complete posterior furrow at the level of the brain. There are two pairs of eyes forming the corners of a rectangle. The anterior has its pigment cup directed laterally, and the posterior is roundish. The eyes were not visible after preservation with hot formalin. By transparence the living worms showed a frontal sense organ, long cephalic glands, and intestinal diverticula.

The base is pear-shaped and as long as the central stylet itself.

Discussion. *T. candidum* is the only species of *Tetrastemma* already known from Caribbean waters (Corrêa 1954, p. 10). *Tetrastemma vermiculus* (Quatrefages, 1846, not Stimpson, 1857) from the same region was removed by Friedrich (1935, p. 340) to his genus *Prostomatella* due to its dissolved proboscoidal septum.

I compare *candidum* with the following new species.

Tetrastemma worki, new species

Figures 32-34

Material. Nine worms in winter 1958/59.

Type. One set of 12 μ transverse sections (14 slides) under the number M 4 deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, Brazil.

Description. The living filiform mature worms measured up to 20 mm in length and 0.3 mm in maximum width. After preservation the measurements are 10 and 0.5 mm respectively. During normal gliding the anterior end is slightly narrower than the rest of the body. The high contractibility makes it possible that a 12 mm long worm diminishes to 2 mm. The anterior and the posterior ends are slightly rounded. The uniform color is milkish-white or yellowish-white. There are two transverse cephalic furrows (Fig. 34, u). The anterior one behind the eyes (e) is more distinct and deeper than the posterior one at the level of the brain. Both cephalic furrows are V-shaped; the vertices are directed backwards. There is a pair of large eyes (e) localised antero-dorsally with the black pigment cup directed to the antero-lateral borders of the head. The eyes are still visible after preservation with hot formalin. The cephalic gland, frontal sense organ (f), brain, diverticula of the gut (m), gonads (n) and proboscis can be seen by transparence in the living worms.

The epidermis is high and very rich in eosinophilous glands. The basement membrane is thick. The muscular layers, external circular and internal longitudinal, reach the tip of the head. The cephalic gland is large, situated both dorsally and ventrally to the rhynchodaeum and extends posteriorly to the brain.

The esophagus opens into the rhynchodaeum at the level of the cerebral sense organs. It is small and poor in glands. At the level of the brain it opens into the large and glandular stomach which is lined with a ciliated epithelium. The gut presents a ventral median caecum under the stomach with lateral pouches. The lateral diverticula of the gut are numerous and unbranched.

The rhynchodaeum pore is narrow and situated sub-terminally. The rhynchodaeum is muscular and rich in glands. The pre-cerebral septum is closed, as it has the shape of a complete diaphragm around the limit between rhynchodaeum and rhynchocoel. The long and wide rhynchocoel has almost the same length as the body. The proboscis is very strong in comparison with the dimensions of the body itself. The anterior chamber (Fig. 33, a) is the longest of the proboscidial chambers. The armed chamber or diaphragm (d) shows a central stylet (Fig. 32, c) as long as the cylindrical base (b) which may be narrower at the hind end. There are two pouches each containing 2 to 4 accessory stylets (Fig. 33, r). The diaphragmatic glands (g) occupy two zones on the posterior of the diaphragm (d). The bulbous vesicle (v) is not so strongly muscular as usually in the *Monostilifera*. The

anterior and posterior chambers are lined with a villous epithelium. The proboscoidal retractor is very thick. There are 10 proboscoidal longitudinal nerves. The wall of the anterior chamber is composed of a high external epithelium, a thin layer of circular muscles, a thicker layer of longitudinal muscles, and a very flat internal epithelium.

The haemal system consists of a dorsal vessel situated between the rhynchocoel and the intestine, two lateral vessels running under the lateral nerve cords, and two pre-cerebral vessels united anteriorly by a commissure.

The brain has two dorsal and two ventral ganglia connected by a thin dorsal and a thick ventral commissure. The lateral nerve cords have only one fiber nucleus. The cerebral sense organs are small, simple, and lie laterally, far in front of the brain. A frontal sense organ is situated over the rhynchodaeal pore at the tip of the head.

The worms are dioecious. Both sexes were well developed at the time of collection. Completely mature worms may have about 50 pairs of gonads alternating with the intestinal diverticula, and located both dorsal and ventrally to the nerve cords.

Remarks. I have named this species *worki* in honor of Mr. Robert Work of The Marine Laboratory, University of Miami, through whom my work was greatly aided.

Discussion. *T. worki* differs from the five other species of the genus known from the Atlantic coast of North America (Coe 1943, p. 291-297) and from the seven species known from the Brazilian coast (Corrêa, 1954, p. 69; 1957, p. 259-269; 1958, p. 452) by the presence of only one pair of eyes. In his revision of the monostiliferous genera Friedrich (1955) considers the sub-antarctic species *T. hansii* Bürger, 1893, as the only species of *Tetrastemma* bearing two ocelli. Although there could be some doubt about this point (Bürger, 1893, p. 222; 1899, p. 7; Wheeler 1934, p. 274 pl. 16 f. 6), the South Georgian species differs from *worki* by its variable color, smaller size and longer cephalic gland.

Two ocelli instead of four, the normal number for the genus, distinguish *worki* also from *candidum* with four eyes.

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STUDIES ON THE CROWN CONCH *MELONGENA CORONA* GMELIN¹

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ABSTRACT

Melongena corona was studied at several locations on the Florida Gulf coast. Salinity tolerances, as determined in the laboratory, correspond to salinities of habitats occupied by this snail. It can live for long periods down to 8‰, although ultimate survival requires higher salinities. *Melongena* can live in habitats subject to daily salinity changes ranging between 12 and 24 ‰. Higher salinities, approaching oceanic, are not harmful. Embryos and larvae *in capsulo* are more sensitive than adults to reduced salinities. The snail has been observed to feed on a variety of detrital and living material, including oysters, but the evidence makes it doubtful that the crown conch is a serious oyster predator. Reproduction of *Melongena* is typical of the prosobranch gastropods. The embryonic stages are described. Measurements of egg capsule size and content show a relation of these factors to the size of animals in the adult population.

INTRODUCTION

The crown conch, *Melongena corona* Gmelin, occurs in great numbers along the Florida Gulf coast, where its presence in shallow water habitats, particularly on intertidal oyster reefs, has drawn much attention to its feeding habits. The decline of oyster production in Tampa Bay has raised questions regarding the possible role of *Melongena* as a predator on *Crassostrea*. In addition, northwest of Tampa Bay to beyond Pensacola, the crown conch is often associated with poorly producing oyster reefs, and the casual observations of oystermen lead them to believe *Melongena* is the main reason for low oyster production. This paper reports aspects of the life history and ecology of this interesting gastropod both as a contribution to our knowledge of marine snails, and as an attempt to clarify the relationships between crown conchs and oysters.

A number of studies report aspects of *Melongena* biology that will not be discussed in this paper. Movements of crown conchs on and around oyster bars appear to be considerable, especially when animals are collected and released in a different place. Under these circumstances, Caldwell (1959) near Cedar Key, Florida, measured move-

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ments of at least 249 feet from the point of release. In addition, a low percentage of recovery of released animals during subsequent collecting trips indicates a dispersal of animals from the point of release. Numerous trawls in the area showed *Melongena* to be virtually absent in the subtidal zone. Hathaway (1958), in Alligator Harbor, Florida, found that animals removed up to 150 meters from the collecting station quickly moved back to the area where they were originally found. Untouched crown conchs remained within the small area of their preferred habitat for many months.

Both of these authors observed the absence of small *Melongena* on oyster bars, as well as the burying behavior of the animals, especially during cold weather. Hathaway (loc. cit.) found very small *Melongena* buried in the sand in the high intertidal zone among the roots of *Spartina alterniflora*. It was inferred that crown conchs move to oyster reefs after a period of growth in nursery areas. *Melongena* on oyster reefs were found to be sexually mature and predominantly female, whereas these animals on soft bottoms, beaches, and in salt marshes included immature animals, and had a sex ratio closer to unity.

The present study presents further observations of the ecology and behavior of *Melongena*. Experiments on salinity tolerance of adult *Melongena* were performed in St. Petersburg and in Tallahassee at the authors' respective laboratories. Field observations of hydrographic conditions under which these gastropods exist have supplemented the experiments. Other aspects covered in this paper are feeding habits, shell form and growth, reproductive activity and morphology, egg capsule deposition, egg capsule size and content, and external salinity variations tolerated by embryos within the egg capsules. The developmental stages of *Melongena* from the unfertilized ovum to the time of hatching are also described.

Most data concern *M. corona corona*, but some of the observations were made in the cline between *M. corona corona* and *M. corona johnstonei* (Clench and Turner, 1956).

METHODS

Salinity tolerances were determined by placing snails in aquaria which were then maintained at given salinities. In the St. Petersburg experiments animals were kept in normal sea water, distilled water, and at intermediate salinities of 20, 15, 8, 7, 6, 5 and 0 parts per thousand, the last value being represented by fresh river water. In

Tallahassee similar experiments were carried out at 33, 21, 15, 13, 11, 10, 9, and 8 ‰. Salinities were measured with hydrometers. General activity and time of death, if it occurred, were observed.

Hydrographic conditions in areas occupied by *Melongena* were measured with most attention given to salinity. Areas studied in north-west Florida were the St. Marks River estuary in Wakulla County and Indian Lagoon in Gulf County. At St. Marks water samples were taken from the bottom as close to the oyster reef as the tide would

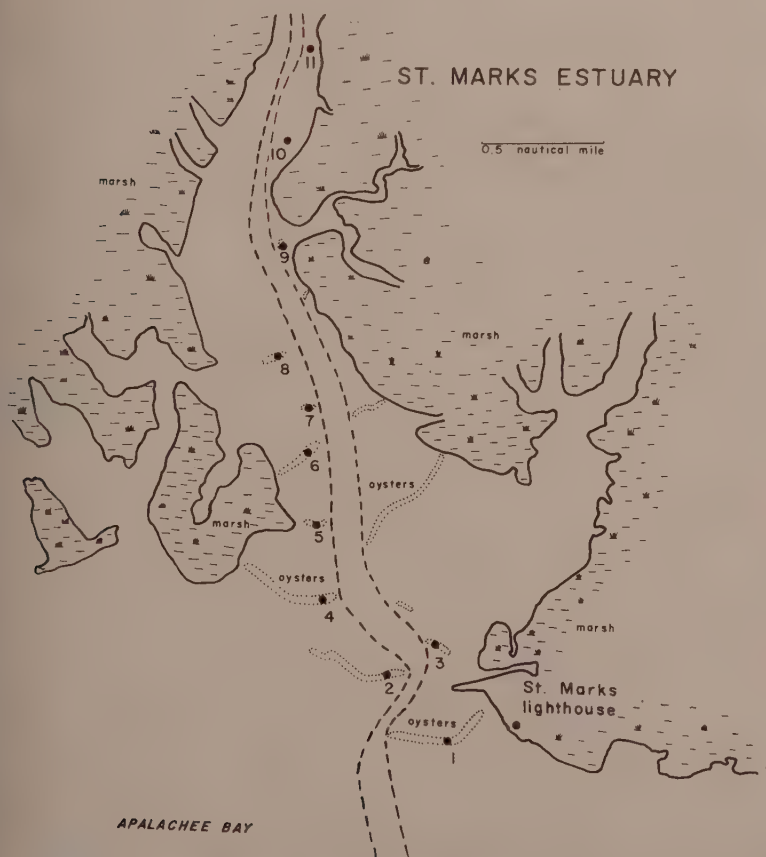


FIGURE 1. The St. Marks estuary, showing stations used in this study.

permit. The stations sampled at St. Marks are shown in Figure 1. Monthly samples from Indian Lagoon were taken from June, 1955 to May, 1956, and then only every three months until January, 1957. Downstate field observations were made in the Tampa Bay area.

The growth of individual animals was observed in specimens in which notches were filed in the growing edge of their shells. When collected some time later, even though the notches were filled in by later calcium carbonate deposits, their outlines were readily seen, and marked the starting point of growth from the day of filing. Growth of newly hatched *Melongena* was unsuccessfully studied in the laboratory. These efforts failed because the young tend to climb above the water level of the aquarium and die in that position (also see Turner, 1959).

Mating and egg capsule depositions were observed both in natural habitats and in sea tables.

Embryological studies were greatly facilitated by the abundance and ready availability of egg cases on Long Bar (Station 1) in the St. Marks estuary. It was possible to find newly laid strings of egg capsules and to rear them to hatching in aquaria. Under these circumstances developmental stages appeared normal as compared with embryos developing in the natural habitat. With laboratory reared embryos and larvae it was possible to follow the normal sequence of development and to estimate the duration of each stage. With knowledge of normal development it was possible to study deviations from normal caused by reduced salinities. A series of experiments was undertaken in which a string of egg capsules was split up into groups of two capsules each. Each group was placed in an aquarium and kept there at a given salinity. At the end of seven days one capsule of each pair was removed and the embryos were examined to determine the stage of development. At the end of another seven days the second capsule of each group was removed and examined. Salinities ranged from 8‰ to 32.8‰. Stages of development represented by embryos at the beginning of the experiment ranged from three days to ten days. Thus it was possible to see how more advanced embryos differed from those less advanced in their response to reduced salinities. Salinities were checked with hydrometers and adjusted with sea water and tap water.

Observations on developing embryos terminated development since the embryos die when removed from egg capsules. Observations were made with a binocular dissecting microscope with a calibrated ocular micrometer which enabled accurate measurements of the eggs and

embryos to be made. Sketches and photographs were used to record observations.

The number of capsules per string, length and width, and numbers of eggs, embryos, or larvae in each capsule were recorded.

SALINITY TOLERANCE EXPERIMENTS

In the St. Petersburg experiments the lowest salinity at which any adult snail survived for more than 11 days was 8‰. One snail survived for over 5 months at this salinity although it never showed any degree of activity such as climbing or moving around the bottom of the aquarium. When the experiments were terminated after more than 5 months, 80% of the snails initially in normal sea water and in salinities of 20 and 15‰ were alive and active.

In the Tallahassee experiments (Table 1) animals at salinities of 9.0‰ and below were inactive and died within 15 days, with the exception of one animal that died on the 19th day. Between 9.0‰ and 21.5‰ activities and survival of animals increased. Normal activity was seen at 12.8‰ and 15.0‰, but ultimate survival seems

TABLE 1

ACTIVITY AND MORTALITY OF ADULT *M. corona* AT REDUCED SALINITIES. ENTRIES INDICATE O: NO ACTIVITY, X: REDUCED ACTIVITY, XX: NORMAL OR SLIGHTLY REDUCED ACTIVITY, D: DEATH. TEMPERATURE 28°C. TWO ANIMALS WERE KEPT AT EACH SALINITY. ANIMALS AND SALT WATER WERE TRANSPORTED FROM ALLIGATOR HARBOR TO THE FLORIDA STATE UNIVERSITY CAMPUS WHERE THE EXPERIMENTS WERE CARRIED OUT.

Salinity ‰	4	6	8	9	13	15	19	27	29
8.0	O	O	O	O	D				
	O	O	O	O	O	O	D		
8.4	O	D							
	O	O	D						
9.0	O	O	O	D					
	O	O	O	O	O	D			
9.9	O	O	O	O	O	O	O	O	O
	O	O	O	O	O	O	O	O	O
11.0	O	O	O	O	D				
	O	O	O	O	O	D			
12.8	XX	XX	X	X	X	X	O	O	D
	XX	XX	X	X	X	X	X	X	X
15.2	O	O	O	O	X	O	O	D	
	O	O	XX	XX	X	X	X	O	O
21.5	XX	XX	XX	XX	X	X	X	XX	XX
32.8	XX	XX	O	XX	XX	XX	X	XX	XX
	XX	XX	XX	X	XX	XX	X	XX	XX

TABLE 2

EXPERIMENTS IN WHICH DEVELOPING EMBRYOS WERE EXPOSED TO REDUCED SALINITIES. A: ANOMALIES, D: DEAD, R: RETARDED, N: NORMAL, H: HATCHED. TEMPERATURE 28°C. ANIMALS AND SALT WATER WERE TRANSPORTED FROM ALLIGATOR HARBOR TO THE FLORIDA STATE UNIVERSITY CAMPUS WHERE THE EXPERIMENTS WERE CARRIED OUT.

Initial Day-Stage of Development		3-4		5	5	5-6	6	9	10
Days Exposure to Lowered Salinity		7 14	7 14	7 14	7 14	7 14	7 14	7 14	7 14
Salinity‰									
8.0	AD	AD	AD	AD	AD	AD	AD	AD	RD
8.4	AD	...	...	...	...	...	AD	...	...
9.0	AD	...	AD	...	...	AD	AD	DD	...
9.9	...	...	AD	AD	...	AD	AD	AA	RD
11.0	AD	...	...	...	AD	AD	AD	AD	...
12.8	...	...	AD	AA	AA	...	...	RR	...
15.2	...	AA	RD	RR	...	...	...	NA	NH*
21.5	AA	R..	NN	...	N..	NN	NN	...	NH
32.8	...	...	...	...	...	...	...	...	NH

*These animals were ready to hatch but had died before doing so.

to depend on higher salinities. One *M. corona* was kept for five months without food at a salinity of 25.0‰ before it died.

At reduced salinities embryos are retarded in their development and often display anomalies (Table 2). Older embryos tolerate lowered salinities better than younger ones. When embryos as young as the third day stage of development were subjected to 21.5‰, anomalies occurred. Most older embryos developed normally at this salinity.

HYDROGRAPHIC STUDIES

The St. Marks Estuary. The St. Marks estuary consists of expanses of intertidal oyster reefs, sand beaches, sand and mud flats, and extensive salt marshes, as well as the main channel of the river (Figure 1). The reefs are made up of small coon oysters which occur in greatest abundance in the low intertidal zone. Higher up on the reefs the substrate is made up of broken oyster shells, packed and ground by the currents to form a hard substrate upon which few living oysters occur. The most notable hydrographic characteristics of the estuary are the effects of tides on conditions on the reefs and bottoms. At high tide the reefs are covered, but as the tide recedes an observer sitting in a boat soon

finds his horizons interrupted in every direction by large reefs. Long Bar (Station 1) is a good example. This reef extends about 900 yards into the mouth of the river, and at low tide it protrudes above water level 4 or 5 feet. The appearance of many such reefs turns the estuary into an alley of barriers with the channel running down the middle. On the reefs themselves the changing tides cause physical disturbances which must be considered in any biological appraisal of the area. The tranquility of full ebb changes to a complexity of eddies as the flood meets the flow of the river. The turbulence increases with the rising water and reaches a maximum when the opposing waters approach the reef tops. The patterns of currents over and around the reefs can be seen distinctly from a small boat. After the flood, the ebb joins the flow of the river to produce currents of high velocity. Interruption of this flow by the first exposure of reef tops increases the turbulence. The change of tide subjects the reefs to another factor—changing salinity. Salinity ranges in most parts of the estuary were found to be 10 to 12‰ (Figure 2). In addition to current and salinity, the biota must accommodate to seasonal changes in temperature which in the water

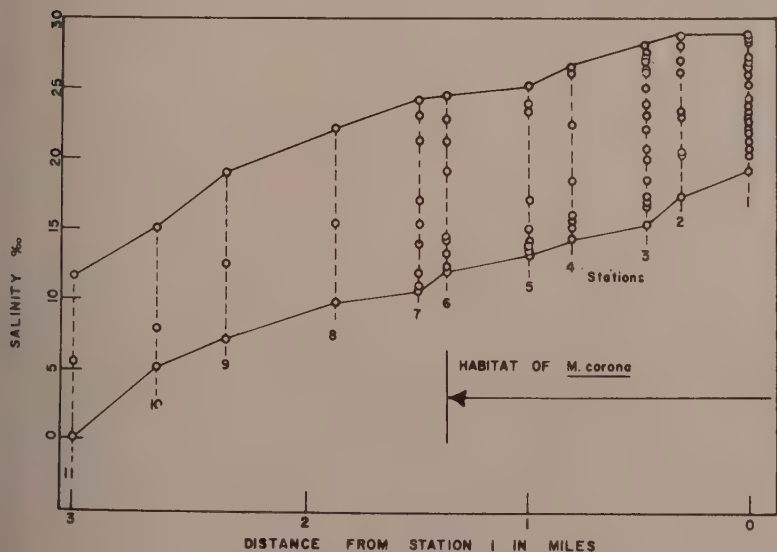


FIGURE 2. Salinities and distribution of *M. corona* on stations in St. Marks estuary.

can range from 10°C to 31°C and in the air from 0°C to over 35°C.

Studies at St. Marks have been carried out at certain stations on oyster reefs. Station 1 is on Long Bar. The other stations are up the river in the order of the numbers used to designate them. *Melongena* have been observed at Station 6 in moderate numbers and at all stations below it, but they are never seen farther up the river. *Melongena* are abundant on Long Bar, and on the intertidal grass flats in that part of the river.

TABLE 3

PHYSICAL DATA FROM THE REEF IN INDIAN LAGOON. THESE DATA TAKEN FROM MENZEL, HULINGS AND HATHAWAY (1958)

Date	Temperature °C	Salinity ‰
24 June 55	28.5	36.3
15 July 55	33.0	31.0
9 Aug. 55	32.0	29.1
15 Sep. 55	27.5	22.9
11 Oct. 55	23.0	29.5
15 Nov. 55	23.0	31.2
13 Dec. 55	8.0	29.1
24 Jan. 56	13.5	30.4
14 Feb. 56	15.0	23.5
22 Mar. 56	13.0	32.9
17 Apr. 56	19.0	35.3
22 May 56	27.0	36.6
11 Aug. 56	33.0	...
11 Sep. 56	25.0	23.9
18 Nov. 56	20.5	30.7
30 Jan. 57	26.5	26.5

Indian Lagoon. Indian Lagoon presents remarkably constant environmental conditions over a broad area. The Lagoon is 2 nautical miles long and is ½ mile wide at its broadest point. It is characterized by large tracts of intertidal oyster reefs. The subtidal bottom is very soft mud in all places except the mouth, where it is loose sand. Depth at low water is less than 6 inches. This shallowness results in very low vertical stability so that the slightest surface disturbance creates currents along the bottom and keeps the lagoon in a perpetually highly turbid condition. The intertidal shoreline supports a mixed mud-oyster-marsh grass community.

Observations were made in the middle of the lagoon where an oyster reef abounds with *Melongena*. This intertidal reef is about 200

by 20 yards in length and breadth. The bottoms adjacent to this reef are soft mud, the nearest solid bottom being more than $\frac{1}{4}$ mile away. Physical data for this reef are given in Table 3.

FEEDING HABITS

About 100 crown conchs were observed in Hillsborough Bay (Eastern Tampa Bay) feeding on fish scraps dumped from a bait house pier. In another part of Tampa Bay fifteen *Melongena* were discovered feeding on a dead horseshoe crab, *Limulus polyphemus*. Since the water was clear and there was a definite current where feeding was taking place an opportunity was provided for testing the relative sight and smell responses of *Melongena* under field conditions. The *Limulus* was freed of *Melongena* and placed $1\frac{1}{2}$ yards down-current from them. Nothing happened after 15 minutes of waiting so the horseshoe crab was moved $1\frac{1}{2}$ yards up-current from the conchs. Within fifteen minutes 12 of the 15 conchs had reached the crab and were rasping at its fleshy parts with their extended radulas. This suggests that *Melongena* is attracted to food by chemical stimuli in the water.

In Tampa Bay the crown conch is often seen feeding on banded tulip shells, *Fasciolaria hunteria*, which occur abundantly on oyster reefs.

To test whether *Melongena* kept in the laboratory were feeding on the lush growths of algae which occurred in the aquaria, an experiment was initiated in St. Petersburg with three aquaria at 32‰ salinity. Three snails were placed in an all glass aquarium of several gallons capacity and placed in the dark. Three snails were placed in each of two identical aquaria and exposed to light. After only a few days, only one snail remained alive in each of the three aquaria (one dark and two light). The dead ones were apparently victims of cannibalism.

This experiment ended when the last surviving snail in the darkened aquarium died after 872 days without feeding. Its light-exposed companion died after 114 days without feeding.

These findings indicate that *Melongena* can live for long periods without food.

An aquarium was maintained for six weeks in St. Petersburg during which time *Melongena* were fed both live oysters and shucked meats (*Crassostrea virginica*). The snails showed a preference for live oysters on which they were observed feeding. However, the actual initiation of feeding or attack was never observed. Live shrimp were

also placed in this aquarium, and when they died the snails consumed them.

The Florida horse conch, *Pleuroploca gigantea*, was the only species observed to prey on *Melongena* during this investigation.

GROWTH.

The technique employed for measurement of growth did not give consistent information from which a representative growth rate could be computed. Caldwell (1959) reached a similar conclusion after using the same method. Evidently growth is irregular in the larger *Melongena* that occur on oyster reefs.

REPRODUCTION

Most observations on mating and egg capsule deposition were made in the field at St. Marks and in Tampa Bay. Depositions were also observed in sea tables of the laboratory of the Oceanographic Institute at Alligator Harbor.

Mating.—One large group of *Melongena corona* was brought in from the field on July 1, 1956, and placed in the sea table. That night three pairs were observed to mate. The male holds the female firmly, his foot spread over the ventral side of her spire and covering the posterior of the aperture. In this manner, with siphonal canals in the same direction, the male is able to insert the penis. In the sea table this position was held from an hour and thirty minutes to an hour and forty minutes. The separation was rapid and complete. Copulating pairs will tolerate some little disturbance, since the three pairs in the sea table were transferred *in copulo* to another sea table, and copulation continued apparently normally. Seven pairs were seen mating on Long Bar during the daylight hours. No night field observations were made.

Egg Capsule Deposition.—Nine *M. corona* have been observed depositing egg capsules, eight at St. Marks and one in the sea table. The latter was one of the animals observed mating on July 1. After copulation, it had been isolated, and was discovered depositing capsules on July 19, a period of 19 days after mating. It deposited six capsules at that time. The time required to deposit these capsules was not determined, but prolonged periods of deposition are common in allied gastropods (Magalhaes, 1948; Ostergaard, 1950). One of the other animals mating on July 1 deposited 13 egg capsules some-

time between July 21-26, a period of 21-26 days since mating. This deposition was not observed.

In the field, deposition is never discovered until after it has been interrupted. The newly laid capsules are hidden by the female which is laying them, and they are, therefore, not seen until after the animal is picked up. The discovery of newly deposited egg capsules with no adult in the immediate vicinity is indicative that the female normally leaves the capsules as soon as they are deposited and shows none of the brooding behavior common to certain gastropods. (Ostergaard, 1950.)

Deposition is made on a solid substrate. At Long Bar strings have been found mostly on old shells and pieces of living grass. One string was found on the protruding neck of an occupied *Chaetopterus* tube. At the Alligator Harbor laboratory, egg capsules were found on the wooden sides of the sea tables, on the wire baskets in which the animals are kept, and on old shells left in the sea table. At Indian Lagoon one string was found on the shell of a living *M. corona*, and numerous strings were found attached to a very long piece of fencing wire resting on the soft mud bottom of the lagoon. In this instance suitable substrates were rare and many capsules had been deposited on capsules previously laid down. Deposition usually takes place on subtidal bottoms. Perry and Schwengel (1955) report intertidal deposition of *M. corona* egg capsules.

Male Genital Ducts.—The prominent penis is located to the right of the head. During normal activity it is carried concealed in the mantle cavity, folded flat against the visceral mass. The penis is somewhat flattened so that a cross-section of it is elliptical in outline. The end is forked, with one prong of the fork being larger and more rigid than the other. The smaller prong is folded against the larger one. The duct runs up the center of the penis to open at the end of the larger fork. From the base of the penis the duct proceeds along the visceral mass to the right, parallel to the lip of the mantle. It is seen in low relief in this position. At the far right side of the mantle cavity the duct makes a right angle turn to the posterior. Near the anus it is seen as a tube passing from the visceral mass into the tissue next to the rectum. At this point it is of larger diameter and represents the anterior part of the prostate gland. This rests on the right (inner) side of the animal, under the large kidney. The most posterior part of the prostate is just inside the pericardial cavity. The vas deferens enters the prostate gland at its midpoint. This tube connects the prostate with the

vesicula seminalis, a prominent coiled structure which passes to the gonad at the tip of the spire. The entire reproductive tract is a closed system, with all the ducts fused around their whole circumference.

Female Genital Ducts.—The most anterior duct is seen in relief on the right side of the visceral mass. It extends posteriorly from the orifice near the mantle edge to near the rectum, where it passes through the mantle cavity to the dorsal capsule gland. The capsule gland is an enlarged structure, quite obvious in the mature female, lying anterior to the large kidney and above the anus. Its posterior end is near the pericardial cavity. Back of the capsule gland is an assemblage of structures representing the albumen gland, the receptaculum seminalis, and the ingesting organ. Between the albumen gland and the ovary is the transparent and delicate oviduct.

Gonadal Activity.—Cytological examination of gonadal tissue from animals collected at St. Marks on February 14, 1957, revealed gametogenic activity in the testes but none in the ovaries. Gross examination of St. Marks animals on March 30, 1957, revealed gametogenic activity in both sexes; however, no egg capsules had been deposited on the reef up to that time. Experience during the summer of 1956 indicated copulatory activity in both sexes at St. Marks until at least the middle of July. In Tampa Bay copulation was first observed in February 1956, in water of 21°C, and was seen until mid-October.

EGG CAPSULES

The egg capsules are lens-shaped structures found in strings of six to twenty capsules each. These are illustrated in Clench and Turner (1956). Forty-nine strings from St. Marks have been examined and a mean value of 12 capsules per string calculated. The dimensions of

TABLE 4
DATA ON EGG CAPSULES FROM ST. MARKS AND INDIAN LAGOON

	Mean	Range
Eggs per capsule (185 examined)	110 $\pm$ 34	15 -273
Capsule length mm (192 examined)	13.6 $\pm$ 1.3	9.7- 23.0
Capsule width mm	14.2 $\pm$ 1.5	10.1- 23.0
<i>Indian Lagoon</i>		
Eggs per capsule (18 examined)	335 $\pm$ 62	192 -560
Capsule length mm (121 examined)	20.1 $\pm$ 1.2	15.6- 25.8
Capsule width mm	21.2 $\pm$ 1.4	17.3- 26.8

the capsules have been measured (Table 4). The embryos within the capsules are suspended in a albumen-like material which becomes less viscous as the time for hatching approaches. A *Melongena* ovum has quantities of yolk which nourish the embryo, but it is possible that albuminous capsular material is consumed in later growth.

Extensive collection and examination of egg capsule strings indicate dimensions of the Indian Lagoon capsules are greater than those of the St. Marks capsules. Correspondingly Indian Lagoon capsules contain more eggs than do St. Marks capsules. Indian Lagoon *Melongena* are larger than those at St. Marks so these results are not surprising (Hathaway, 1958).

DEVELOPMENT

The spherical ovum of *Melongena corona* measures 295-320 micra in diameter (Fig. 3a). The newly laid egg frequently has two polar bodies still attached to it. It consists largely of opaque yolky material with a little cytoplasm at the animal pole. Cleavage is preceded by a concentration of cytoplasm in the area where the spindle will form. The first cleavage furrow is accompanied by the formation of a small polar lobe. In two and four cell stages and for a short time after formation of micromeres the spherical shape is distorted into a two and four lobed figure. Shortly, however, the spherical shape is regained. The first two cleavages are holoblastic and equal. At this time it is possible to distinguish the poles by the concentration of cytoplasm (animal) and the appearance of the polar furrow (vegetal). The third and succeeding cleavages are concentrated around the animal pole and are unequal. These cleavages rapidly give rise to the first, second, and third quartets of micromeres. When the micromeres have divided enough to create a cap of ectoblast over the animal pole, the macromeres pull together to give the embryo a spherical shape once again (Fig. 3b). At this time the ectoblast begins the process of epiboly, the various stages of which have not been observed in detail in this study. It is only a matter of 24 to 48 hours from the ectoblastic cap stage to the time when embryos show ciliary movement and elaboration of the larval kidneys (Fig. 3c). These appear on each side, slightly below the equator, as large transparent hemispheres 40 to 50 micra in diameter. These structures are described in *Busycon* by Conklin (1897), and in *Fasciolaria* by Glaser (1905) as embryonic excretory organs. They persist for the whole of the embryonic life.

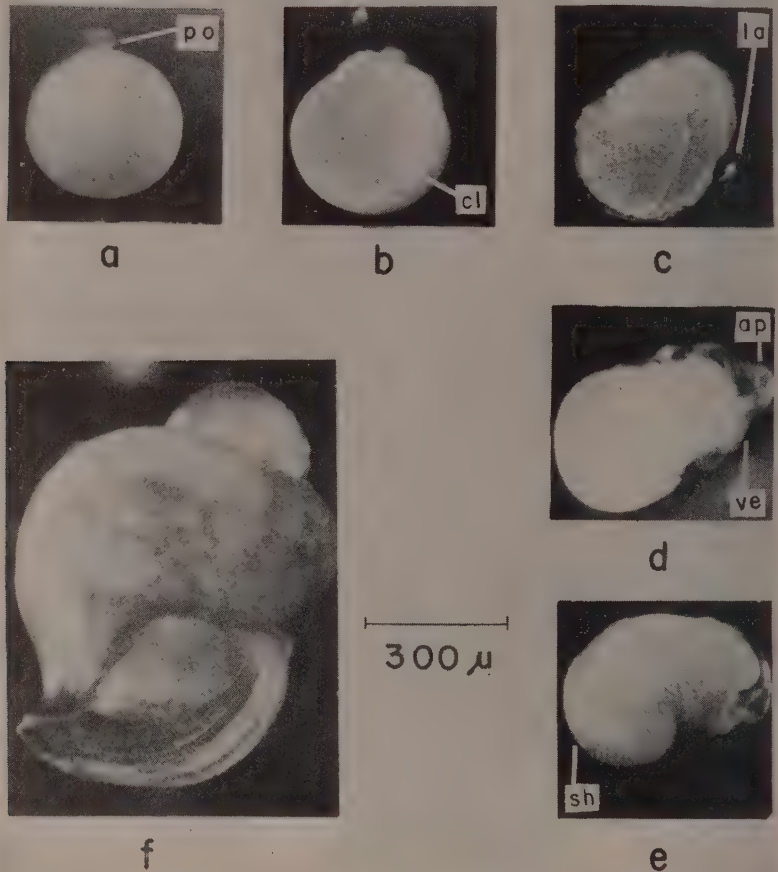


FIGURE 3. Development of *M. corona*. (a) uncleaved ovum, po: polar body. (b) ectoblastic cap stage, cl: cleavage furrow between macromeres. (c) trochophore, la: larval kidney. (d) early veliger, ap: apical plate, ve: velum. (e) early veliger, sh: shell cap. (f) shell at time of hatching.

Shortly before the appearance of larval kidneys the first movements of the embryo indicate the presence of cilia. A rudimentary velum soon appears, first as a bilobate protuberance just anterior to the vegetal pole and to either side of the ciliated apical plate (Fig. 3d), and then as large ciliated organs, with shapes suggesting butterfly wings (figures in Clench and Turner, 1956). At this time the large yolk laden cells of the fourth quartet are easily seen.

The first signs of shell deposition appear as the vellum begins to form (Fig. 3e). On the posterior surface of the elongating embryo a slightly granular cap appears. Its growth is continuous and rapid and is accompanied by organogenesis in other parts of the embryo. At the same time the volume of yolk material begins to diminish rapidly. The foot begins to develop shortly after the first appearance of the shell. Soon the stomadeum can be seen between the foot and the anterior part of the velum. Anterior to the mouth tentacles and eye spots appear. At the base of the velum and dorsal to it the larval heart is first detected by its rapid and regular contraction. The shell, as it grows over and covers the larval heart, first shows the asymmetry that results in a dextral animal. The siphonal canal appears at this time. By the time the animal is ready to hatch the shell has become an opaque structure with dimensions of 700 micra wide and 900 micra long (Fig. 3f). Clench and Turner (1956) state that the larva is not ordinarily pelagic.

An approximate timetable of development from the uncleaved ovum to hatching is given below. These embryos were reared at 28°C and at a salinity of 30.0‰.

<i>Time Since Laying</i>	<i>State of Development</i>
Up to 12 hours	Two cells
" 24 "	Four cells
" 48 "	Well defined macromeres and micromeres
" 72 "	Spherical shape restored. Ectoblast at the animal pole only.
Up to 4 days	Spherical. Diameter equal ca. 300 micra.
" 5 "	Slight elongation. First movement. Larval kidneys well defined.
" 6 "	Velum and shell gland rudiments obvious
" 7 "	Shell elaboration
" 8 "	First contractions of the larval heart
" 9 "	Heart almost covered by shell
" 14 "	Shell has 1¼ whorls
" 16 "	Shell has 1½ whorls
" 20 "	Hatching 700 x 900 micra.

DISCUSSION

Salinity.—*Melongena* can tolerate not only low salinities, as shown in laboratory experiments, but also daily salinity variations of at least 12‰. At Station 6 in the St. Marks estuary a moderate number of crown conchs exist where salinities have been measured from about 12‰ to 24‰. Under these conditions, however, the animals do not carry on normal reproductive activity. On Long Bar, Station 1, large numbers of *Melongena* live and reproduce even though daily salinities have been observed to vary from 20-29‰ in a few hours. These observations correspond very well to the laboratory experiments, which show that adult *Melongena* tolerate much lower salinities than developing embryos. This implies that crown conchs further up the river have migrated from areas down the river where they were hatched.

Feeding habits.—The diet of the crown conch has often been discussed (Perry and Schwengel, 1955; Gunter and Menzel, 1957; Hathaway, 1958; Menzel and Nichy, 1958; Caldwell, 1959; Turner, 1959). The present report is in agreement with characterizations of *Melongena* as a scavenger. Olfaction appears to be the most important sense in this respect. With regard to the *Melongena* feeding on horseshoe crab, there is no way of telling whether the conchs had actually killed the crab or if they were merely continuing where disease or some predator had left off. Turbid or polluted waters, such as found near industrial regions of Tampa, do not deter crown conchs. They find food while gliding along on a muscular foot, with the siphon extended and waving laterally. Although the foot travels generally in a straight course, the body and shell are twisted from side to side through almost 180 degrees.

Evidence for serious predation of *Melongena* on commercial oysters is lacking in spite of efforts to prove that it occurs. In all cases in which the conchs have been seen feeding upon oysters, the conditions suggest that the oysters are in weakened conditions. This paper reports the consumption of oysters by *Melongena* in the laboratory (St. Petersburg) where the bivalves succumbed to predation under unnatural conditions. On oyster reefs, crown conchs appear to be most successful in inserting their proboscises into oysters during the hot summer months. The internal temperature of an oyster was measured by Nichy (1956) in Alligator Harbor during August, and was found to be 37.6°C. Under these conditions Nichy found that he could open many oysters by compressing the valves anterior to the hinge ligament.

This is an indication of the weakened condition of these oysters. It probably indicates that most intertidal oysters in Florida are similarly weakened during the summers. Data of Menzel and Nichy (1958—Observations of 4 individuals of *Melongena* caged in their natural habitat, for a period of 165 days) and Hathaway (1958—Observations of 6 individuals of *Melongena* caged in natural habitats for up to 38 days, and of 6 in aquaria for 60 days) indicate that mortality due to *Melongena* predation is no greater than ordinary mortality. It is possible that crown conchs eat only sick and dying oysters. It is not uncommon to see *Melongena* on oyster reefs feeding on oysters. Menzel and Nichy (1958) observed this "rarely," and Caldwell (1959) reported it as "occasional."

Data from the present report regarding salinity tolerance and distribution of *Melongena* indicate that crown conchs cannot succeed in many of the areas where oysters flourish and grow to commercial sizes. Experience in Apalachicola Bay (Menzel, Hulings, and Hathaway, 1958) has shown that *Melongena* does not occur on subtidal oyster reefs which are regularly flushed by fresh or brackish river water (e.g., Station 2. Menzel, Hulings, and Hathaway, 1958). On such reefs, not only crown conchs, but many proven oyster predators are absent. Probably, reduced salinities account for this.

In areas where crown conchs occur, subtidal oysters are rare. The restriction of oysters to the intertidal zone has been studied by Nichy (1956) who demonstrates very clearly that predators such as *Busycon contrarium* and *Murex pomum* are highly effective in killing oysters in Alligator Harbor. Since these proven predators occur mostly below mean low water, and since *Melongena* is mainly an intertidal animal, it seems likely that a lack of subtidal oysters is due to *Busycon*, *Murex*, and other predators.

The evidence indicates that in the comparatively highly saline waters in which *Melongena* occur, oyster mortality is probably due to some other factors. Environmental causes such as the high temperature on intertidal reefs, high salinities, and the activities of proven predators, probably account for low oyster production in places where crown conchs abound.

In the experience of one of us (KDW) who for the past several years has been involved in ecological studies encompassing most of the oyster producing area of Florida, the depredations of man clearly appear to be an additional significant factor in the decline of oyster productivity.

Shell Growth and Form.—On the basis of shell form, Clench and Turner (1956) have said that two subspecies of *M. corona* live on the north coast of Florida. The cline between subspecies *M. corona corona* and *M. corona johnstonei* is said to cover the area of the present study. Populations from Indian Lagoon and St. Marks are widely separated geographically and display differences between each other which can be appraised in terms of the cline. *M. corona* of Alligator Harbor and St. Marks bear a close resemblance to *M. corona corona* as described and pictured by Clench and Turner (1956). Since Alligator Harbor is within the range given for *M. corona johnstonei*, one might expect to find there a form more closely resembling the latter subspecies. The appearance of Alligator Harbor animals is different from that of animals from Indian Lagoon. The latter animals closely resemble pictures and description of *M. corona johnstonei* as given by Clench and Turner (1956). Indian Lagoon animals possess a corollary row of spines near the anterior of the shell, a trait present in *M. corona corona* but absent in the more western forms of *M. corona johnstonei*. With respect to spire length, coloration, corrosion of the spines, however, Indian Lagoon animals are typically *M. corona johnstonei*. It would thus appear that populations sampled in this study represent stages of the cline between the two subspecies. An Indian Lagoon animal, resembling *M. corona johnstonei*, and a St. Marks animal, resembling *M. corona corona*, are shown in Figure 4.

When one considers the process of growth in which later whorls

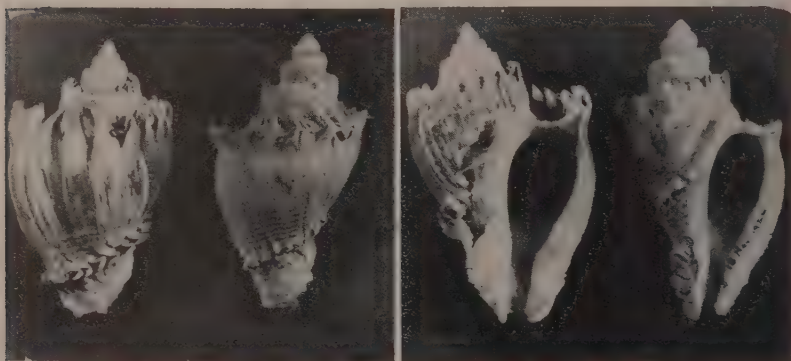


FIGURE 4. Left: *M. corona* from St. Marks, right: *M. corona* from Indian Lagoon.

wind around earlier ones, the question of the fate of the row of corallary spines must be considered. These spines, formed just posterior to the siphonal canal, are eventually located on the parietal wall of the aperture, in which position they present an obstacle to the movement of the animal in and out of its shell. Examinations of many shells have indicated that the animal has some way of removing these obstacles. By the time the new whorl has grown around, the corallary spines of the previous whorl have been removed, and the former outer surface of the shell has been smoothed over. There is no information on how these spines are removed. It is suggested that the mantle may have the ability to resorb or dissolve the calcium carbonate of the shell when any part of it becomes undesirable. Since the mantle is the structure adapted to deposition of the shell, it might also have a resorption function.

An anomaly within the main population at St. Marks was seen when a large (168 mm) animal was collected whose shell was perforated with boring sponges. Ordinarily *Melongena* are not infested with boring sponges. Two sponges were tentatively identified as *Cliona celata* Grant, and *C. caribboea* Carter. Determinations are based on the size of the megascleres and the absence of microscleres (Old, 1941). An attempt to relate this information to the "Cliona" zones (Hopkins, 1956) postulated for Gulf coast estuarine waters can lead only to the conclusion that the individual *Melongena* in question had not spent any time in waters more brackish than those in which it was found, since *C. celata* is one of the species found in the more saline waters, and *C. caribboea* is thought to have similar preferences.

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CONCLUSIONS

1. Large groups of *Melongena* thrive in areas of the Florida Gulf Coast where salinities show ranges from 20 to 29‰ with each change

in tide. Higher salinities are no barrier to this animal, and it is quite capable of living at lower salinities since moderate numbers have been found in places with a daily salinity range between 12 and 24‰.

2. Adults of *Melongena* tolerate lower external salinity than larvae in capsulo.

3. *M. corona* feeds on a wide variety of living and dead material. It is probably of considerable importance as a scavenger. A good sense of "smell" guides it to food in the highly turbid water where it often lives.

4. Observations on oyster reefs establish that *Melongena* sometimes feed upon intertidal oysters. In the St. Petersburg laboratory *Melongena* in aquaria consumed live oysters; however, as previously reported, captive crown conchs in northwest Florida did not contribute to oyster mortality. The lack of exhaustive experimental evidence leaves open the question of the degree to which *Melongena* predation is a factor in oyster mortality.

5. The intertidal distribution of *Melongena* and its well defined limited tolerance for fresh water eliminate it as a threat to subtidal oyster bottoms in estuaries regularly flushed by fresh water.

6. Growth appears to occur in spurts between periods of rest. This is common in marine gastropods (Abbott, 1955). No growth period, seasonal or otherwise, was found to be common to an entire sample population.

7. Reproductively, the crown conch is typical of the prosobranch gastropods. The genital tract is of an advanced, closed type. The course of larval development follows the general pattern of gastropod eggs with large amounts of yolk. The shell of the hatched larva is relatively massive, which may account for a brief or non-existent pelagic life.

8. Egg-capsule size and egg content are related to the size of the animal depositing them. In populations of large animals an average of 335 eggs per capsule were counted, whereas in a population of smaller animals this figure was 110.

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WESTERN ATLANTIC FISHES OF THE GENUS *HAEMULON* (POMADASYIDAE): SYSTEMATIC STATUS AND JUVENILE PIGMENTATION¹

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ABSTRACT

Thirteen species of the genus *Haemulon* Cuvier from the western Atlantic are described, illustrated and discussed and keys presented for determination of adult and juvenile forms. Particular attention is paid to juvenile pigmentation with regard to identification. The genera *Brachygenys* Scudder and *Bathystoma* Scudder are synonymized with *Haemulon*.

Eleven species of the genus occur throughout the Caribbean including southern Florida. *Haemulon bonariense* Cuvier is restricted to the West Indies and *Haemulon steindachneri* (Jordan and Gilbert) to the northern coast of South America and the eastern Pacific. *Haemulon schranki* Agassiz may not be identified with any known species of the genus at the present time.

INTRODUCTION AND ACKNOWLEDGMENTS

The genus *Haemulon* Cuvier, of the percoid family Pomadasyidae (=Haemulidae, Haemulonidae), includes fifteen species, twelve of which are known from the tropical and subtropical western Atlantic, two from the tropical eastern Pacific and the remaining form from both sides of Central America. These fishes, referred to as the scaled-fin grunts, include the nominal genera *Bathystoma* and *Brachygenys* which are here considered synonyms of *Haemulon*.

The present study treats the following species of *Haemulon* from the western Atlantic: *Haemulon sciurus* (Shaw), *H. melanurum* (Linnaeus), *H. steindachneri* Jordan and Gilbert, *H. parrai* (Desmarest), *H. flavolineatum* (Desmarest), *H. carbonarium* Poey, *H. album* Cuvier, *H. bonariense* Cuvier, *H. macrostomum* Günther, *H. plumieri* (Lacépède), *H. aurolineatum* Cuvier, *H. chrysargyreum* Günther, and *H. striatum* (Linnaeus). For purposes of discussion the thirteen species are grouped on the basis of similar morphology.

The species of *Haemulon* are inshore forms, inhabiting shallow areas from the shore to the edge of deep water. Certain species show preferences for clear water free of suspended calcareous marl while others are more ubiquitous, being abundant on grass flats, and in boat harbors, channels and deep pools along the shoreline. They are

¹Contribution No. 306 from The Marine Laboratory, University of Miami. This paper was submitted in partial fulfillment of the degree of Master of Science, University of Miami, Coral Gables, Florida.

also found on the reefs. These factors are discussed with the species accounts.

Juvenile fishes of this group have long presented problems to the taxonomist largely because of apparent morphological homogeneity. On the other hand, adults of these species are, for the greater part, very distinct, but poor descriptions, illustrations, and artificial keys to identification due to insufficient examinations of series of specimens have left this important group confused. The present study presents a comparison of the juvenile fishes of the genus *Haemulon* and evaluates the adults.

I wish to express my gratitude to Dr. C. Richard Robins of The Marine Laboratory, University of Miami, for his patience, advice, and criticism throughout the preparation of this manuscript and for the privilege of using the collections in the research museum. I also wish to thank the following persons for their aid in securing material for this study: Walter A. Starck, II, of The Marine Laboratory, who obtained the bulk of the juvenile material on his extensive collecting trips to the Alligator Reef area of the Florida Keys and in the Eastern Bahamas, Dr. James E. Böhlke of the Academy of Natural Sciences of Philadelphia for making available specimens from the Chaplin Bahamas Program and aiding in the literature survey, Dr. Robert H. Gibbs of Boston University for specimens from off the South American coast, Dr. Reeve M. Bailey of the Museum of Zoology, University of Michigan, for the loan of juvenile material, Dr. David K. Caldwell of the United States Fish and Wildlife Service, Brunswick, Georgia, for the loan of Jamaican specimens, Dr. Ernest A. Lachner and Mr. Robert Kanazawa for their generous aid while at the United States National Museum, Mr. George Collier, Mr. John Ford, Jr., and Mr. Gordon Ford for making collecting trips to the western Bahamas possible for the author. I also wish to thank Dr. Victor G. Springer for comments concerning the key.

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Mr. Thomas W. McKenney advised the author in the preparation of drawings. All photographs are by the author. I am grateful to my wife, Francine, for her patience and encouragement. This study was supported in part by grants-in-aid from The National Science Foundation (NSF-G-3881 and NSF-G-9695) which the author gratefully acknowledges.

METHODS AND ABBREVIATIONS

Methods of counting and measuring follow those of Hubbs and Lagler (1958: 19-28) unless otherwise stated. Measurements were made to the nearest tenth of a millimeter with dial calipers. The left side of each specimen was used for counting and measuring, unless badly damaged.

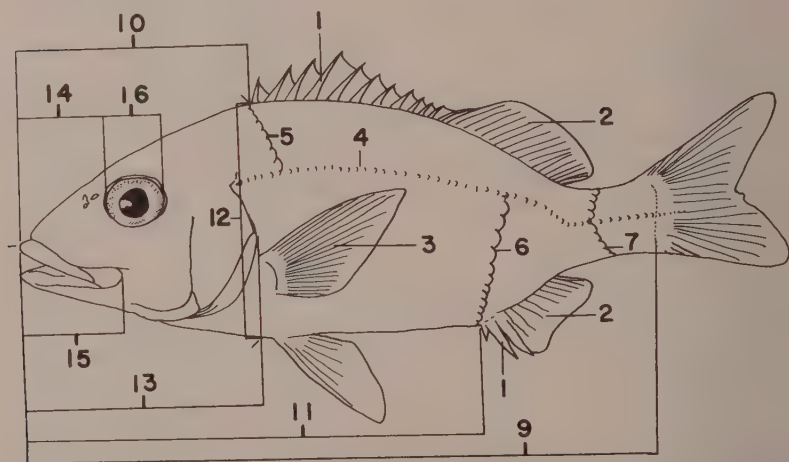


FIGURE 1. Diagram of *Haemulon* illustrating methods of counting and measuring and designating each one by a number.

1. Dorsal and anal spines. Arabic numerals were used in place of Roman numerals to designate dorsal and anal spines. The last dorsal spine, most often associated with the soft-rayed, or second dorsal fin, is designated by a + sign in the fin formulae.

2. Dorsal and anal soft rays. The number of dorsal and anal soft rays is given in Arabic numerals and is separated from the spine count by a comma. The last two rays of the dorsal and anal fins were found by dissection to be connected with one inter-spinal and are counted as one.

3. Pectoral rays.

4. Lateral-line scales. All lateral-line scale counts were made by counting only the pored scales, from the caudal base (Hubbs and Lagler, 1958: 22) anteriorly to the first pored scale behind the opercle.

5. Scales above the lateral line. This count is difficult to determine in the genus *Haemulon* due to the presence of small half-scales at the base of the dorsal fin. The count was made by pulling the first dorsal spine erect and counting from the first complete scale in front of the spine and below the mid-dorsal line to the lateral line.

6. Scales below the lateral line. This count is as difficult as the preceding one and is made in a similar manner, counting from the first complete scale in front of the anal spine above the mid-ventral line to the lateral line.

7. Caudal-peduncle scale count. A total count was used.

8. Gill rakers. All gill rakers on the first arch were counted, including rudiments. Total counts were used.

9. Standard length.

10. Predorsal length. This measurement was made from the tip of the snout to the origin of the first dorsal spine.

11. Preanal length. This measurement was made from the tip of the snout to the origin of the first anal spine.

12. Body depth.

13. Head length.

14. Snout length.

15. Length of upper jaw.

16. Eye length.

Specimens examined during this study are listed by general locality and catalog or field number. The following abbreviations are used to indicate the source of the material:

ANSP—Academy of Natural Sciences of Philadelphia.

ANSP—Chaplin Bahamas Program—uncataloged material; indicated by ANSP followed by a field number.

C-4—field numbers of uncataloged Jamaican material loaned by David K. Caldwell, U. S. Fish and Wildlife Service, Brunswick, Georgia.

CRR-F—field numbers of uncataloged material from Florida; The Marine Laboratory, University of Miami.

CRR-BWI—field numbers of uncataloged material from the Bahamas; The Marine Laboratory, University of Miami.

M V COMBAT—uncataloged material; loaned by the U. S. Fish and Wildlife Service, Brunswick, Georgia.

R V ATLANTIS—uncataloged material loaned by Robert H. Gibbs, Jr. of Boston University.

UMML—The Marine Laboratory, University of Miami.

UMMZ—Museum of Zoology, University of Michigan.

USNM—United States National Museum, Washington.

The number of specimens examined and their range of standard length is given in parentheses following the catalog or field number. For example, four specimens ranging in standard length of 25 to 108 mm would be represented as (4, 25-108).

Genus *Haemulon* Cuvier

Diabasis Desmarest, 1823: 30 (generic definition p. 34, type species

Diabasis parra by subsequent designation [Jordan and Gilbert, 1883c: 553]; not *Diabasis* Hoffmannsegg, 1819, preoccupied in Coleoptera).

Haemulon Cuvier, 1829: 175 (description, type species *Haemulon elegans* Cuvier by subsequent designation [Jordan and Swain, 1884b: 283]).

Haemylum Scudder, 1863: 12 (emended spelling).

Anarmostus Scudder, 1863: 12 (no definition, type species *Diabasis flavolineatus* Desmarest by subsequent designation; not *Anarmostus* Loew, 1860, preoccupied in Diptera).

Bathystoma Scudder, 1863: 12 (no definition, type species *Haemulon aurolineatum* Cuvier by subsequent designation).

Haemulon Cope, 1871: 471 (emended spelling).

Brachygenys Scudder, 1875: 121-122 (no definition, type species *Haemulon taeniatum* Poey [= *H. chrysargyreum* Gunther] by monotypy).

The divisions of this genus have not reflected the affinities of its components. The genus *Haemulon* forms a natural group. Morphometry of the individual species tends to indicate several subgroups which are unnatural and which lose this apparent independence when meristic characters are considered.

The differences between species within *Haemulon* (of authors) are as great as differences between the nominal genera *Haemulon*, *Bathystoma*, and *Brachygenys*. There is no basis for generic separation of *Brachygenys* from *Haemulon*. The more elongate body and smaller mouth that *chrysargyreum* possesses seem no more worthy of generic ranking than the characteristics of many other species of *Haemulon*. The genus *Bathystoma* does not form a natural unit within itself. *B. striatum*, if it is to be closely allied to any other species of *Haemulon*, would seem closer to *chrysargyreum*. It is certainly not close to *aurolineatum*. If *Bathystoma* can be considered a separate genus on the basis of thirteen dorsal spines instead of the twelve characteristic of *Haemulon*, then *H. melanurum*, *album* and *steindachneri* could be elevated to the same rank on the basis of a higher caudal-peduncle scale count. *H. parrai* could also receive such recognition on the basis of its scaled pectoral fins.

Evidently, the present classification of the group has ignored natural affinities. *Bathystoma* and *Brachygenys* are here synonymized with *Haemulon*. The same arguments rule against their recognition as subgenera. Future investigation may reveal *Lythrulon* and *Orthostoeus*, eastern Pacific pomadasysids, should be placed in *Haemulon*.

ARTIFICIAL KEY TO THE WESTERN ATLANTIC

SPECIES OF THE GENUS *Haemulon*

1. Specimens 65 mm or greater in standard length2
1. Juveniles 15 mm to 65 mm in standard length (see figures for younger stages)14
2. Dorsal spines 13 (12 + 1)3
2. Dorsal spines 12 (11 + 1)4
3. Scales around caudal peduncle 22 (usually 9-2-11 sequence); gill rakers 24 to 28; dorsal rays 14 to 15; anal rays usually 9 *aurolineatum*
3. Scales around caudal peduncle 24 or more, usually 26; gill rakers 27 to 36; dorsal rays 13 to 14; anal rays 7 to 8; body not strongly compressed *striatum*
4. Scales around caudal peduncle 23 or more, not 22; scales below lateral line 13 to 145
4. Scales around caudal peduncle 22 or less, usually in 9-2-11 sequence; scales below lateral line 12 to 13, usually 127
5. Back below dorsal fin, upper half of caudal peduncle and caudal fin black as in Fig. 2b; caudal peduncle scales 23 to 25, usually 23; gill rakers 21 to 23; anal rays 8 *melanurum*
5. Scales around caudal peduncle usually 25 to 26; body without black dorsal stripe of *melanurum*6
6. Black blotch beneath free margin of preopercle absent; body generally without stripes following scale rows, but when present formed by spot in center of each scale (in large juveniles only); eye small; pectoral rays 18 or 19 *album*
6. Large black blotch beneath free margin of preopercle; body striped as in Fig. 2c., stripes on scale rows running through each scale; pectoral rays usually 17 to 18; from inshore waters of Panama to Brazil and eastern Pacific along Central America *steindachneri*
7. Dorsal rays 13, rarely 12 or 14; gill rakers 29 to 34; mouth very small as in Fig. 5c; longitudinal scale rows below lateral line parallel to long axis of body *chrysargyreum*
7. Dorsal rays 14 to 188
8. Body with dark stripes as in Fig. 4b; pectoral fins not scaled; scales large; pored lateral-line scales 45 to 48, usually 46; dorsal rays 15 to 16 *bonariense*
8. Body without dark stripes as in Fig. 4b9
9. Pectoral fins scaled for more than 1/3 of length; body with stripes as in Fig. 3a formed by spots in center of scales above lateral line; dorsal rays 16 to 18, usually 17 or 18; pored lateral-line scales 47 to 49, usually 48 *parrai*
9. Pectoral fins not scaled; no dark stripes on body as in Figs. 3a or 4b10
10. Scales below lateral line larger than those above and in oblique rows as in Fig. 3b; gill rakers 21 to 24, usually 23 *flavolineatum*

10. Scales of equal size on both sides of lateral line or larger above lateral line 11
11. Scales above lateral line larger than below and in 5 oblique rows; head with numerous dark stripes as in Fig. 5a.; anal rays 8 to 9, usually 9; pectoral rays 17, rarely 16 *plumieri* 12
11. Scales of equal size above and below lateral line 12
12. Gill rakers 23 to 25; body striped as in Fig. 3c; dorsal rays 15 to 16, usually 15; anal rays 8; eye large *carbonarium* 13
12. Gill rakers 26 to 31, rarely 25; anal rays usually 9 13
13. Mouth large; pectoral rays 17 to 18, usually 18; color pattern as in Fig. 4c.; pored lateral-line scales 50 to 52, usually 51 *macrostomum* 13
13. Body with longitudinal stripes as in Fig. 2a.; pectoral rays 16, rarely 17; pored lateral-line scales 48 to 51 *sciurus* 13
14. Lateral stripe from tip of snout or behind eye to area of caudal peduncle present 15
14. Lateral stripe absent; caudal spot round, barely touching caudal base as in Figs. 12b-d and 13a; head with heavily scattered small melanophores; scales above lateral line larger than those below *plumieri* 15
15. Lateral stripe continuous with spot at base of caudal fin (when viewed with unaided eye) 16
15. Lateral stripe not continuous with caudal spot (except small melanophores continuing from terminus of stripe to caudal spot but not appearing as part of lateral stripe when viewed with unaided eye; this case is more the exception than the rule) 18
16. Lateral stripe moderately dark to light, not swollen at terminus, entering oval spot at caudal base; anterior edge of caudal spot touching caudal base as in Figs. 6b-d and 7a; mid-dorsal line of nape without dark stripe originating at dorsal fin origin *sciurus* 16
16. Lateral stripe swollen at terminus or constricted and oblique at caudal base 17
17. Lateral stripe swollen dorso-ventrally at terminus to form second caudal spot, constricted at caudal base, entering caudal spot posterior to caudal base as in Figs. 7b-d and 8a-b *melanurum* 17
17. Lateral stripe constricted and oblique posterior to caudal base, entering amorphous spot on caudal fin as in Figs. 14b-c *chrysargyreum* 17
18. Caudal spot and lateral stripe intensely dark, often black or dark brown; melanophores on head and body very dark; spot wedge-shaped as in Figs. 11c-d and 12a *macrostomum* 18
18. Caudal spot and lateral stripe usually not intensely dark, sometimes light; caudal spot not wedge-shaped as in *macrostomum* 19
19. Caudal spot round, barely touching caudal base as in Figs. 8c-d and 9a-b; mid-dorsal line of nape with dark stripe originating at dorsal fin origin *parrai* 19
19. Caudal spot oval or dumbbell-shaped 20
20. Caudal spot large, centered over caudal base and occupying large area of caudal peduncle as in Fig. 10c *carbonarium* 20
20. Caudal spot not as in *carbonarium* 21
21. Caudal spot oval, 2/3 of spot posterior to caudal base; front of spot slightly spread dorso-ventrally at caudal base; lateral stripe barely entering caudal peduncle as in Figs. 10d and 11a-b *bonariense* 21
21. Caudal spot oval or dumbbell-shaped, centered over caudal base 22
22. Caudal spot not constricted at caudal base (Figs. 9c-d and 10a-b); scales below lateral line larger than those above; longitudinal scale rows below



FIGURE 2. a—*Haemulon sciurus* (Shaw), CRR-F-120, southern Florida, adult, 141 mm standard length. b—*H. melanurum* (Linnaeus), UMML 3226, Florida Keys, juvenile, 99 mm standard length. c—*H. steindachneri* Jordan and Gilbert, UMML 5008, off Venezuela, juvenile, 87 mm standard length.



FIGURE 3. a—*Haemulon parrai* (Desmarest), CRR-F-219, southern Florida, adult, 183 mm standard length. b—*H. flavolineatum* (Desmarest), CRR-F-120, southern Florida, adult, 120 mm standard length. c—*H. carbonarium* Poey, UMMI. 2372, western Bahamas, adult, 182 mm standard length. (Posterior margin of opercle damaged.)



FIGURE 4. a—*Haemulon album* Cuvier, UMML 5328, southern Florida, adult, 536 mm standard length. b—*H. bonariense* Cuvier, USNM 132551, Haiti, adult, 151 mm standard length. c—*H. macrostomum* Günther, UMML 1393, Puerto Rico, adult, 235 mm standard length.



FIGURE 5. a—*Haemulon plumieri* (Lacépède), CRR-F-112, southern Florida, adult, 173 mm standard length. b—*H. aurolineatum* Cuvier, UMML 1084, Florida Keys, adult, 111 mm standard length. c—*H. chrysargyreum* Günther, CRR-F-193, Florida Keys, juvenile, 93 mm standard length. d—*H. striatum* (Linnaeus), R/V ATLANTIS, off Venezuela, adult, 139 mm standard length.

- lateral line oblique (view with directional light) *flavolineatum*
 22. Caudal spot oval or slightly constricted at caudal base, appearing dumbbell-shaped in large juveniles (30 mm or greater in standard length) as in Figs. 13b-d and 14a; scales of equal size on both sides of lateral line; longitudinal scale rows below lateral line parallel to long axis of body (view with directional light); dorsal spines 13 *aurolineatum*

Haemulon sciurus (Shaw)

BLUESTRIPED GRUNT

Figs. 2a, 6a-d, 7a, Tables 1-10

Anthias formosus Bloch, 1792: 122-124, Pl. 323 (in part; description; Antilles; figure in color, good).—Bloch and Schneider, 1801: 305 (compiled; St. Croix).—Bancroft, 1835: 84 (Jamaica).

Sparus sciurus Shaw, 1803: 439, Pl. 64 (original description; type locality: American seas).—Swain, 1883: 305 (in part; incorrectly referred to *Serranus formosus* Linnaeus).

Haemulon elegans Cuvier, 1829: 175 (allied to *A. formosus* Bloch); in Cuvier and Valenciennes, 1829: 227-230 (description; Martinique); 1834: 156 (in part; compiled); 1836: 84, Pl. 30, Fig. 1 (name only; figure good).—Guichenot, 1843: 178-179 (characters; compiled).—Günther, 1859: 306 (characters, synonymy, range; compiled).—Poey, 1865: 309 (Santa Cruz; Martinique; Puerto Rico; Santo Domingo).—Adams and Kendall, 1891: 300 (Garden Key, Tortugas).—Lönnberg, 1894: 127 (Key West; observed).—Smith, 1896: 176 (Biscayne Bay; observed).—Jordan and Evermann, 1917: 128 (name only).

Diabasis obliquatus Bennett, 1835: 90-91 (description; Jamaica).

Haemulon sciurus, Storer, 1846: 74 (compiled).—Jordan, 1884a: 126 (Key West); 1884c: 78 (name only).—Jordan and Swain, 1884b: 301-303 (synonymy, characters; compiled; good color description).—Goode and Bean, 1886: 207 (description of skin in Linnaean collection).—Jordan, 1886: 42 (Havana); 1887a: 878 (name only); 1887c: 584 (compiled).—Jordan and Bollman, 1889: 551 (Green Turtle Cay, Bahamas).—Bean, 1890: 205 (Cozumel).—Adams and Kendall, 1891: 309 (compiled).—Henshall, 1891: 379 (Garden Key and Key West).—Jordan and Fesler, 1893: 474, Pl. 38 (compiled; figure excellent).—Henshall, 1895: 217 (Key West).—Garman, 1896: 78 (Tortugas).—Jordan and Evermann, 1896: 384 (compiled).—Brice, 1898: 282 (compiled; food value).—Jordan and Rutter, 1898: 109 (Kingston).—Jordan and Evermann, 1898: 1303-1304; 1900: Pl. 205, Fig. 531 (compiled; figure excellent).—Evermann and Kendall, 1900: 77 (compiled).—Evermann and Marsh, 1900: 189-190, Fig. 53 (compiled; Puerto Rico).—Fowler, 1903: 330 (compiled; Biscayne Bay).—Barbour, 1905: 122 (Hamilton Harbor, Bermuda).—Bean, 1905: 308 (Bahamas).—Jordan and Thompson, 1905: 242 (Bush Key, Tortugas).—Bean, 1906: 57-58 (Bermuda).—Fowler, 1906: 98, Fig. 11 (Marquesas; Jewfish and Bahia Honda Keys, Fla.; figure fair).—Blosser, 1909: 298 (St. Croix).—Nichols, 1612: 188 (seen at Havana; Marianao, Cuba).—Reighard, 1915: 33-35 (behavior).—Ribeiro, 1915: 375 (compiled).—Fowler, 1915a: 253 (Hungry Bay, Bermuda).—Jordan and Evermann, 1916: 426, photo-

- graph facing p. 430 (compiled; photograph excellent).—Longley, 1916: 210 (feeding habits); 1918: 83, 84 (photographs).—Ribeiro, 1918: 104-105 (synonymy).—Fowler, 1919: 144 (compiled): 147 (Lucea, Jamaica), 150 (Bahamas), 153 (Soldier Key, Fla.).—Metzelaar, 1919: 79-80 (compiled; Curaçao; Aruba; St. Martin; St. Eustatius).—Longley, 1920: Pl. 1, Fig. 2, Pl. 3, Fig. 1 (photographs).—Nichols, 1921: 23 (Turks Island).—Longley, 1922: 172 (color changes).—Fowler, 1923: 22 (compiled), 30 (Tortugas).—Mowbray, 1924: 132 (as yellow grunt; photograph).—Nichols, 1924: 181 (color illustration).—Breder, 1925: 154 (Caledonia Bay, Panama).—Longley, Schmitt and Taylor, 1925: 230 (Tortugas).—Meek and Hildebrand, 1925: 533-534 (compiled; Atlantic coast of Panama).—Breder, 1927: 47 (no locality data).—Longley, 1927a: Pl. 12, bottom, Pl. 15, top (color photographs); 1927b: 76 (photograph).—Beebe and Tee-Van, 1928: 159-160, Fig. on p. 159 (Port-Au-Prince Bay, Haiti).—Borodin, 1928: 20 (Caribbean Sea).—Fowler, 1928: 460 (Guanica, Puerto Rico).—Gudger, 1929: 181-182 (compiled; excellent color observation).—Nichols, 1929: 273, Fig. 144 (compiled; San Juan).—Townsend, 1929: 336 (color observations), Fig. 317 (alarm pattern), Pl. 13 (color phases).—Fowler, 1929: 639 (compiled).—Burkenroad, 1930: 17-18 (Sound production).—Fowler, 1930b: 147 (Bermuda).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Manter, 1930: 338 (as host for trematodes).—Parr, 1930: 55, Fig. 9 (Turks Island; excellent figure).—Beebe and Tee-Van, 1933b: 154, photograph facing p. 156 (compiled).—Longley, 1933: 2, bottom (illustration).—Breder, 1934: 59 (South Bight, Grassy Creek, Andros, observed; Grassy Creek, Andros).—Beebe and Hollister, 1935: 216 (observed at Union Island, Grenadines, British West Indies).—Fowler, 1939: 13 (compiled); 1941: 161 (compiled).—Longley and Hildebrand, 1941: 125-126, Pl. 13, Figs. 1-2, Pl. 14, Fig. 2, Pl. 15, Figs. 1-2, Pl. 18, Figs. 1-2 (behavior; coloration).—Fowler, 1942a: 75 (Havana); 1942b: 11 (Sheen Cays and Bonacca Island, Honduras); 1944: 107, 446, 466 (compiled; Courtown Keys, Bahamas); 1945: 306 (compiled; Key West).—Breder, 1948a: 304 (observed at Bimini); 1948b: 178, figure (compiled).—Schultz, 1949: 135 (compiled).—Roig, 1950: 180 (compiled).—Arnov, 1952: 430-432 (compiled).—Fowler, 1952: 95 (compiled; Port-Au-Prince).—LaMonte, 1952: 109, Pl. 44, top (compiled; figure fair).—Fowler, 1953: 64 (Cartegena, Colombia).—LeDanois, 1957: 94 (photograph).—Briggs, 1958: 279 (compiled).—Rasquin, 1958: 23-24 (melanophores on head; pineal organ), 37, Table 2 (effects of hormone injection), 48 (effects of adrenalin), Pl. 4, Fig. 1 (dorsal view or head), Fig. 2 (oblique transverse section through pineal vesicle).—Duarte-Bello, 1959: 88 (compiled).
- Haemulon formosus*, Castelnau, 1855: 10 (color description; Bahia; incorrectly referred to *Capeuna* of Marcgrave).
- ?*Haemulon similis* Castelnau, 1855: 11 (inadequate description; Bahia; possibly young of *sciurus* or *melanurum*).
- Haemulon luteum* Poey, 1860: 174-176 (description; Havana), 354 (brief color comparisons); 1861a: 369 (compiled); 1868: 317 (compiled); 1875: 118 (compiled; incorrectly lists *Perca formosa* Linnaeus in synonymy).—Diaz, 1893: 91 (compiled).—Howell-Rivero, 1938: 199 (synonymy).

Haemulon multilineatum Poey, 1860: 178-179 (description; Cuba); 1861a: 369 (compiled); 1868: 318 (compiled); 1875: 118 (compiled).—Howell-Rivero, 1938: 199 (synonymy).

Haemylum elegans, Scudder, 1863: 12 (name only).

Haemulum elegans, Cope, 1871: 471 (St. Croix).

Haemulum luteum, Cope, 1871: 471 (compiled; St. Martins).

Diabasis elegans, Bean, 1883: 58 (Key West).—Goode and Bean, 1883: 238 (Gulf of Mexico).

?*Haemulon hians* Haly, 1875: 268 (inadequate description; Bahia, Aspinwall; probably *sciurus*, fide Jordan, 1887c).

Material examined.—Florida: UMML 3329 (1, 67.9); UMML 1053 (4, 70.8-107.6); UMML 551 (5, 72.7-116.8); UMML 4316 (5, 73.7-96.9); UMML 1401 (2, 77.7-113.6); UMML 1898 (1, 77.8); UMML 234 (4, 82.2-124.8); UMML 356 (1, 97.9); UMML 5284 (3, 11.4-20.6); UMML 2591 (1, 27.8); UMML 937 (1, 57.2); UMML 4841 (1); UMML 4799 (3); USNM 15815 (1); ANSP 90010 (15); CRR-F-120 (1, 141.0).

Western Bahamas: UMML 2944 (4, 39.2-86.7).

Jamaica: C-4-1959-1J (1, 52.4).

Diagnosis.—Pored lateral-line scales 48 to 51; caudal-peduncle scales 22 (9-2-11); dorsal fin 11+1, 16 to 17, usually 16; anal fin 3, 9; pectoral fins 16 to 17, usually 16; gill rakers 27 to 31, usually 29. Body bronze above, yellow on sides, cream on belly with blue stripes from head to caudal peduncle. Dorsal fin membranes yellow; soft dorsal, caudal and anal fins dusky gray to black; pelvic and pectoral fins chalky. Black blotch often present beneath free margin of preopercle. Juveniles with lateral stripe continuous from behind eye to oval-shaped caudal spot at caudal base.

Description.—A moderately large species; mature adults average slightly more than 200 mm in standard length. General body form and pattern are illustrated in Fig. 2a. The posterior margin of the upper jaw reaches to a point below the center of the eye. The preopercle is not serrated in the adults.

The dorsal fin includes twelve spines and the anal fin three. Dorsal-, anal- and pectoral-ray counts are given in Table 7.

The longitudinal scale rows below the lateral line are slightly oblique and almost parallel to the long axis of the body. Scale counts are given in Tables 8 and 9. The gill rakers of the first arch are short. Counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are graphed in Fig. 15.

Coloration.—The typical color pattern is shown in Fig. 2a. In life the stripes are pale blue on the head and body as far as the caudal base. The areas between are yellow, becoming bronze-yellow dorsally to

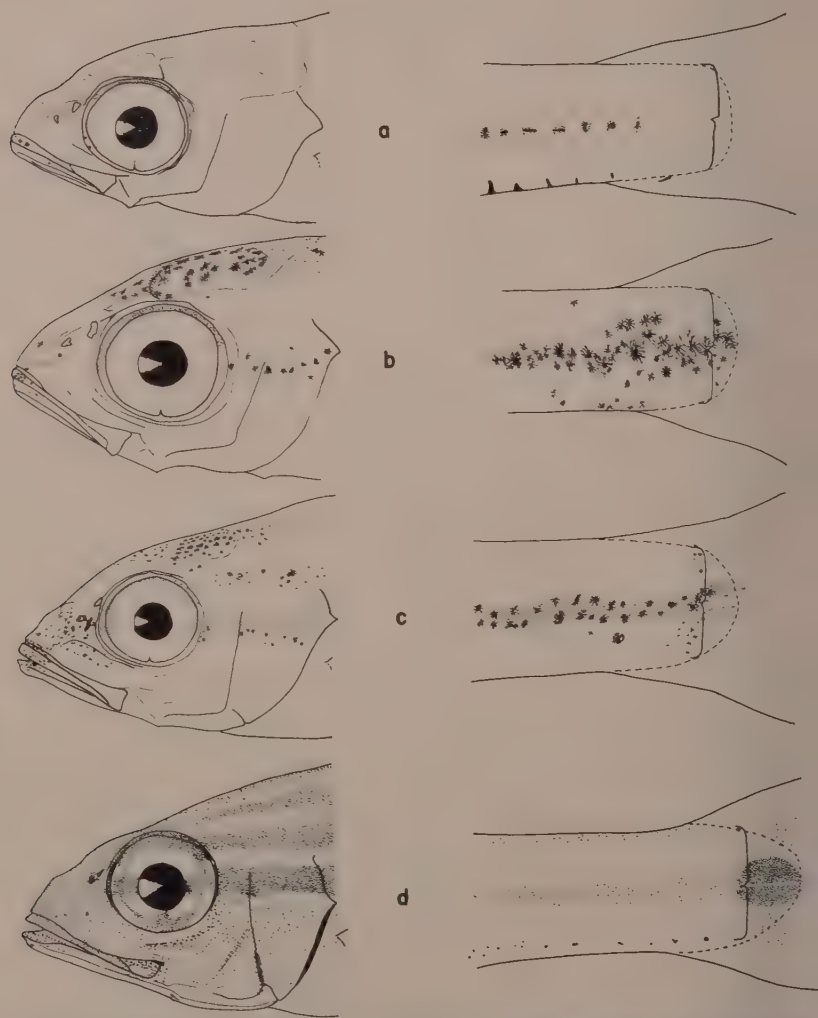


FIGURE 6. *Haemulon sciurus*: a—UMML 5284, Florida Keys, 11.4 mm standard length. b—UMML 5284, 14.9 mm standard length. c—UMML 5284, 20.6 mm standard length. d—UMML 2591, western Bahamas, 27.8 mm standard length.

1961]

Courtenay: *Genus Haemulon*

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cream or white along the belly. The yellow pigmentation may become bronze when this species is encountered in clear water areas. A black blotch may be present beneath the free margin of the preopercle. The mouth is red within.

The membranes of the spinous dorsal fin are yellow. The soft dorsal and caudal fins are dusky gray to black. The soft anal fin is dusky gray. The pectoral and pelvic fins are chalky.

The peritoneum is black.

Juvenile pigmentation.—Between 35 and 65 mm in standard length juvenile *sciurus* approximate the life colors of the adult form. The colors fade in alcohol and the characteristic juvenile pattern is retained.

Juvenile pigmentation is shown in Figs. 6a-d and 7a. In young individuals less than 22 mm in standard length melanophores are very prominent on the caudal peduncle. The caudal spot is beginning to spread posterior to the caudal base. As growth continues, the individual melanophores on the head and body blend into a dusky gray or black lateral stripe which is uninterrupted from behind the eye to an oval caudal spot. The anterior edge of the caudal spot extends slightly in front of the caudal base over the posterior margin of the hypural plate. When the fish attains 50 mm or greater in standard length the caudal spot spreads onto the caudal fin and the adult pattern appears.

Comparisons.—On the basis of general morphology *sciurus* is most closely related to *melanurum* and *steindachneri*. These species are easily distinguished by body coloration when fresh or recently preserved. The characteristic black area along the dorsum, upper half of the caudal peduncle and on the caudal fin in *melanurum* is characteristic of that species alone and serves to distinguish it from others. Gill-raker counts will separate these two species as shown in Table 10. Gill-raker counts and scales around the caudal peduncle distinguish *sciurus* and *steindachneri*.

Two other species, *flavolineatum* and *carbonarium*, are yellow-striped in life. *H. flavolineatum* can be distinguished by the scales below the lateral line which are larger than those above. *H. carbonarium* differs from *sciurus* in gill-raker and fin-ray counts. The color pattern of *carbonarium* is different in that the bronze stripes on the head are broken into blotches below the eyes (Fig. 3c). Neither *flavolineatum* nor *carbonarium* have blue stripes on the body.

Juveniles of *sciurus* closely resemble those of *melanurum* in that the lateral stripe is continuous with the caudal spot. The spot of *melanurum* originates at the caudal base (Figs. 7b-c), the lateral stripe spreading anteriorly with growth. The reverse is true in *sciurus*, the spot appearing after the lateral stripe is formed. (Figs. 6a-b) The caudal spot of *melanurum* spreads dorso-ventrally at the caudal base, is constricted over the posterior margin of the hypural plate and spreads slightly anterior to the caudal base causing the end of the lateral stripe to appear as a second, smaller spot (Figs. 7d, 8a-b).

Distribution and ecology.—The range of *sciurus* extends from the Miami area of southern Florida southward throughout the West Indies to Brazil and along the coast of Central America into the southern Gulf of Mexico. Occasional stragglers move northward along the Atlantic coast as far as South Carolina in the summer months. It is recorded from Bermuda.

This species is very abundant in the waters of Florida and the western Bahamas from the shore to the edge of deeper water. It is most often encountered in groups with *plumieri* in inshore waters and along the outer reefs where large schools are formed. Juvenile forms are particularly abundant in shallow inshore waters and are not often collected on the reefs.

Haemulon melanurum (Linnaeus)

COTTONWICK

Figs. 2b, 7b-d, 8a-b, Tables 1-10

Perca marina caude nigra Catesby, 1743: 7, Pl. 7, Fig. 2 (brief description; figure in color, good; no locality data).—Jordan, 1884b: 193 (synonymy).

Perca melanura Linnaeus, 1758: 292 (original description, based on Catesby's figure as type; type locality: America).—Gmelin, 1788: 1319 (compiled).—Walbaum, 1792: 350-351 (compiled).

Grammistes melanurus, Bloch and Schneider, 1801: 185 (compiled).

Sparus melanurus, Shaw, 1803: 429 (compiled).

Haemulon dorsale Poey, 1860: 179 (description; Cuba); 1861a: 369 (compiled); 1868: 161, 318 (compiled); 1875: 118-119 (compiled).

—Diaz, 1893: 91-92 (compiled; color description).—Howell-Rivero, 1938: 198-199 (synonymized with *melanurum*).

Bathystoma melanurum, Scudder, 1863: 12 (based on *Perca melanura* Linnaeus).

Haemulon melanurum, Cope, 1871: 471 (New Providence, Bahamas; St. Martins; St. Croix, Virgin Islands).

Haemulon melanurum, Jordan and Swain, 1884b: 300-301 (characters, synonymy; compiled).—Jordan, 1886: 42 (Havana); 1887c: 584 (compiled).—Bean, 1890: 205 (Cozumel, Yucatan).—Jordan and

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Courtenay: Genus Haemulon

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Fesler, 1893: 473 (compiled).—Jordan and Evermann, 1896: 384 (compiled); 1898: 1302-1303 (characters, synonymy; compiled).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Bean, 1905: 308 (Nassau, Bahamas).—Jordan and Thompson, 1905: 242 (Bush Key, Tortugas, Fla.).—Bean, 1906: 57 (Bermuda).—Jordan and Evermann, 1916: 425-426 (compiled; good color description).—Fowler, 1919: 137, 144, 147, 150 (compiled; Jamaica).—Metzelaar, 1919: 79 (St. Martin; St. Eustatius).—Meek and Hildebrand, 1925: 536 (compiled; not recorded from Panama).—Nichols, 1929: 273 (compiled).—Fowler, 1929: 639 (compiled).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Beebe and Tee-Van, 1933b: 153, Fig. on p. 153 (compiled; figure poor).—Fowler, 1941: 161 (compiled).—Longley and Hildebrand, 1941: 125 (color observations; observed at Tortugas).—Fowler, 1942a: 75 (observed in Cuban collection); 1944: 87 (Roncador Bank), 105-107, Pl. 12, top (misidentification; possibly *carbonarium*; Courtown Keys), 157 (St. Andrews Island), 446, 467 (compiled).—Breder, 1948b: 178 (compiled).—Roig, 1950: 180 (compiled).—Arnov, 1952: 417-418 (compiled).—Fowler, 1953: 63 (compiled).—Briggs, 1958: 279 (compiled).—Rasquin, 1958: 37, Table 2 (in table; effect of hormone injections), 46-48, Table 3 (effect of adrenalin injections), Pl. 9, Fig. 2 (good photograph).—Duarte-Bello, 1959: 87 (compiled).

Material examined.—Florida: UMML 5920 (3, 16.3-18.4); UMML 5894 (4, 10.0-15.2); UMML 2992 (8, 38.5-103.4); UMML 3226 (41, 66.2-134.7); UMML 5034 (2, 164.2-194.7).

Virgin Islands: USNM 39808 (1).

Diagnosis.—Pored lateral-line scales 49 to 51; caudal-peduncle scales 23 to 25, usually 23; dorsal fin 11+1, 15 to 17, usually 16; anal fin 3, 8; pectoral fins 16 to 18, usually 17; gill rakers 21 to 23. Body white with yellow and black stripes; back below dorsal fin, upper half of caudal peduncle and caudal fin black. Dorsal fin membranes chalky; soft dorsal and soft anal fins dusky gray to black; pelvic and pectoral fins chalky. Black blotch often present beneath free margin of preopercle. Juveniles with lateral stripe from behind eye terminating in double caudal spot, constricted over caudal base.

Description.—A moderately large species; mature adults average slightly less than 200 mm in standard length. General body form is shown in Fig. 2b. The posterior margin of the upper jaw reaches to a point below the posterior edge of the lens of the eye. The preopercle is serrated along most of its vertical length in the adults.

The dorsal fin contains twelve spines and the anal fin three. Dorsal-, anal- and pectoral-ray counts are given in Table 7.

The longitudinal scale rows below the lateral line are slightly oblique. Scale counts are shown in Tables 8 and 9. The gill rakers of the first arch are short and counts are given in Table 10.

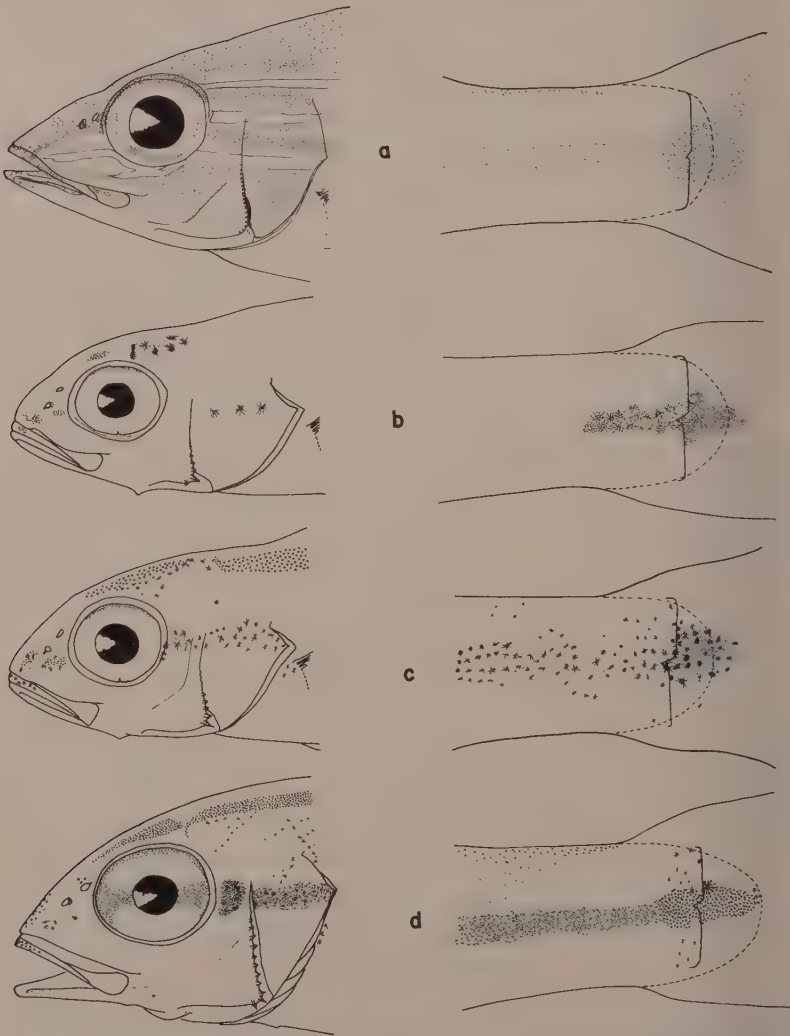


FIGURE 7. *Haemulon sciurus*: a—UMML 937, southern Florida, 57.2 mm standard length. *H. melanurum*: b—UMML 5894, Florida Keys, 11.6 mm standard length. c—UMML 5894, 15.2 mm standard length. d—UMML 5920, Florida Keys, 18.1 mm standard length.

Morphometric data are provided in Tables 1-6 and eye-length - standard length relationships are shown in Fig. 15.

Coloration.—The adult color pattern is shown in Fig. 2b. In life the dark stripes are dusky gray to black. The dark area along the back, caudal peduncle and caudal fin is black. The area between the dark stripes is white, interspersed with thin, light-yellow stripes. The belly is white. A black blotch may be present beneath the free margin of the preopercle. The mouth is pale red within.

The spinous dorsal-fin membranes, the margins of the soft dorsal and caudal fins, the anal, pelvic and pectoral fins are chalky. The base of the soft dorsal fin is dusky gray to black.

The peritoneum is black.

Juvenile pigmentation.—The juvenile pattern is present in most specimens less than 60 mm in standard length. Adult characteristics become evident beyond 65 mm in standard length.

Juvenile pigmentation is shown in Figs. 7b-d, 8a-b. The caudal spot begins as a series of melanophores at the caudal base and spreads anteriorly with growth. Throughout the juvenile and adult stages the lateral stripe is continuous with the caudal spot. The caudal spot spreads dorso-ventrally at the posterior margin of the hypural plate. As growth continues the posterior end of the lateral stripe spreads slightly so as to give the appearance of a second, smaller spot. A constriction is evident between the two spots at the caudal base. As growth continues the caudal spot spreads onto the caudal fin and is joined by a mid-dorsal stripe to form the adult pattern.

Comparisons.—Morphologically *melanurum* appears related to *sciurus* and *steindachneri*. These relationships were discussed under *sciurus*. *H. melanurum* retains its adult pattern of the dark back and caudal fin in preservation and is easily separated from other species by this characteristic.

Juvenile forms are most easily confused with those of *sciurus* and these relationships are discussed with *sciurus*. In some ways young individuals of *aurolineatum* resemble those of *melanurum*. The larger caudal spot typical of *aurolineatum* is centered over the caudal base. The interrupted lateral stripe and thirteen dorsal spines as opposed to twelve distinguishes *aurolineatum* from *melanurum*.

Distribution and ecology.—The range of *melanurum* extends from the upper Florida Keys, Bahamas, and West Indies to Brazil and

along the Central American coast as far as Yucatan. It is recorded from Bermuda.

This species prefers the clearer waters of the outer reefs off Florida and the shallow inshore waters of the Bahamas. It rarely strays into murky waters. Juvenile forms are found in deep water (100 feet or more) on the offshore edge of the outer reefs. They move into shallow waters and school with adults when a size of 35 mm or greater in standard length is reached.

Haemulon steindachneri (Jordan and Gilbert)

Fig. 2c, Tables 1-10

(Atlantic references only, except for original description)

Haemulon caudimacula, Steindachner, 1875: 15 (not of Cuvier, 1829: 176; description; Acapulco; Rio de Janeiro; Rio Grande do Sul, Maranhao).

Diagnosis steindachneri Jordan and Gilbert, 1882: 306 (name only). 322-325 (original description; type localities: Panama; Mazatlan).

Haemulon steindachneri, Jordan and Swain, 1884b: 299-300 (compiled).—Jordan, 1887a: 878 (name only).—Jordan and Evermann, 1896: 384 (compiled); 1898: 1301-1302 (compiled).—Ribeiro, 1904: 28 (Rasa and Grande Islands, Brazil).—Starks, 1913: 46 (Natal, Brazil).—Ribeiro, 1915: 378-379 (characters, range; compiled).—Jordan and Evermann, 1916: 425 (compiled; color description).—Ribeiro, 1918: 106-107 (synonymy; compiled).—Metzelaar, 1919: 79 (compiled; Guanta, Venezuela; Curaçao).—Meek and Hildebrand, 1925: 537-538 (compiled; Panama City market).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Fowler, 1940: 772, Fig. 53 (Rio de Janeiro; figure poor); 1941: 161 (compiled).—Schultz, 1949: 135 (compiled).—Fowler, 1951: 21 (Rio de Janeiro?).—Arnov, 1952: 420-421 (compiled).

Material examined.—Atlantic: Panama: USNM 148671 (2, 87.0-88.1).

Brazil: USNM 39828 (1, 152.5).

Venezuela: UMML 5008 (1, 87.1).

Pacific: Mexico: USNM 19632 (4, 66.6-161.1); USNM 47430 (2, 109.6-120.3). Paratypes, USNM 29778 (1, 127.0); USNM 29795 (1, 132.5); USNM 29226 (1, 133.8); USNM 29759 (1, 121.2); USNM 28172 (1, 131.6).

Gulf of California: USNM 46628 (1, 100.7).

Panama: USNM 50410 (1, 151.2).

Diagnosis.—Pored lateral-line scales 51 to 52, usually 52; caudal-peduncle scales 25 to 26, usually 26; dorsal fin 11+1, 15 to 17, usually 16; anal fin 3, 8 to 9, usually 9; pectoral fins 17 to 18, usually 18; gill rakers 22 to 25. Preserved specimens with dark brown stripes above lateral line formed by lines through each scale and along scale rows. Large black blotch beneath free margin of preopercle. Black spot at base of caudal fin retained in adults.

Description.—A moderately large species; mature adults average approximately 175 mm in standard length. General body form is shown in Fig. 2c. The photograph is of a large juvenile specimen in which the adult characteristics are present.

The posterior margin of the upper jaw reaches to a point below the center of the eye. The preopercle is serrated from the angle along its entire vertical length.

The dorsal fin includes twelve spines and the anal fin contains three. Fin-ray counts are given in Table 7.

The longitudinal scale rows below the lateral line are oblique to the long axis of the body. The gill rakers are short. Scale and gill-raker counts are shown in Tables 8, 9, and 10.

Morphometric data are provided in Tables 1-6 and eye length-standard length graphs are shown in Fig. 15.

The anal fin is very heavily scaled, more so than in any other species of *Haemulon*. Scales must be partially removed to count anal rays.

Coloration.—The color pattern is shown in Fig. 2c. Live or freshly preserved specimens of *steindachneri* were not available to the author. Preserved specimens are striped above the lateral line, the stripes occurring along scale rows and terminating at the base of the dorsal fin. The stripes in the photographed specimen are faded to some extent. All Atlantic specimens have a very dark blotch beneath the free margin of the preopercle.

The peritoneum is black.

Juvenile pigmentation.—Specimens less than 81 mm in standard length were not seen during this study. At 81 mm size the caudal spot is quite large, occupying most of the caudal base as shown in Fig. 2c. This spot is retained throughout life.

Comparisons.—The general morphology of *steindachneri* indicates a relationship with *sciurus* and *melanurum*. The characters which distinguish these species are discussed with *sciurus*.

H. steindachneri strongly resembles *album*, especially in the larger juveniles. The eyes of *steindachneri* are larger than those of *album*. The latter species is characterized by dark spots in the center of the scales when stripes are present. The stripes of *steindachneri* are continuous across each scale. The presence of a black blotch beneath the free margin of the preopercle in *steindachneri* and the absence of this character in *album* is noteworthy.

Distribution and ecology.—In the Pacific Ocean this species occurs

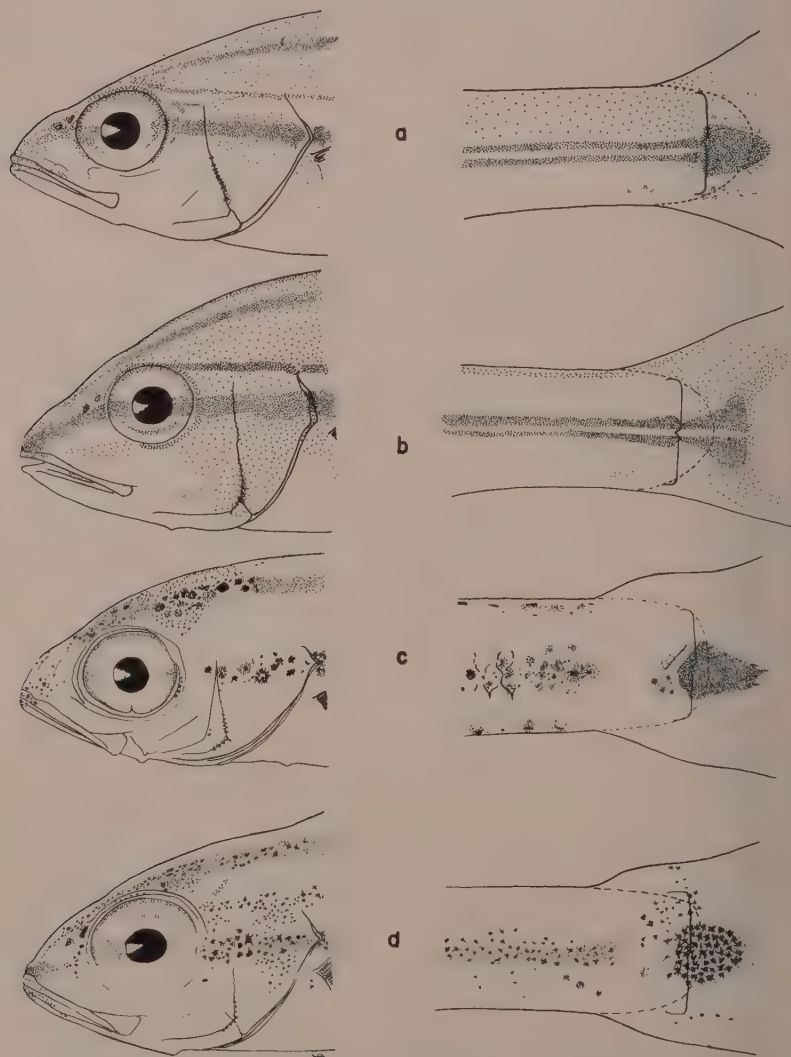


FIGURE 8. *Haemulon melanurum*: a—UMML 2992, Florida Keys, 38.5 mm standard length. b—UMML 3226, Florida Keys, 66.2 mm standard length. *H. parrai*: c—UMML 4679, southern Florida, 12.2 mm standard length. d—UMML 4679, 20.6 mm standard length.

from Panama to the Gulf of California. The Atlantic range is from Panama to Rio de Janeiro. It is not recorded north of Panama.

Little is known of the ecology of *steindachneri* other than depth records. It has been captured in shallow, inshore waters to depths of 30 to 40 fathoms.

Haemulon parrai (Desmarest)

SAILOR'S CHOICE

Figs. 3a, 8c-d, 9a-b, Tables 1-10

Diabasis parra Desmarest, 1823: 30-35, Pl. 2, Fig. 2 (original description; type locality: Cuba).

Haemulon canna Agassiz, 1829: 130-131, Pl. 69 (description; Atlantic; not of Cuvier in Cuvier and Valenciennes, 1829: 233).—Guichenot, 1843: 179 (brief description).—Storer, 1846: 74 (compiled).—Castelnau, 1855: 11 (color note; Bahia, Brazil).—Poey, 1868: 464 (in list of fishes thought not to occur in Cuba).—Jordan, 1885a: 547 (additional characters of type specimen); 1887b: 535 (synonymized with *H. acutum* Poey).—Garman, 1896: 78 (Tortugas).

Haemulon caudimacula Cuvier, 1829: 176 (allied to *D. parra* Desmarest; no definition); in Cuvier and Valenciennes, 1829: 236-237 (description; Brazil); 1934: 156 (synonymy); 1836: 84 (compiled).—Guichenot, 1843: 180 (compiled).—Günther, 1859: 313 (compiled).—Poey, 1861a: 369 (compiled); 1866: 310 (compiled).—Sauvage, 1882: 322-323, footnote (redescription of type).—Jordan, 1887b: 535-536 (Delalande, Brazil).

Haemulon chromis Broussonnet, 1829: 242 (description; Jamaica).—Günther, 1859: 310 (characters).—Jordan, 1887b: 536 (examination of type; allied to *parra*).—Lönnerberg, 1894: 127 (Key West).

Haemulon parra, Storer, 1846: 75-76 (compiled).—Jordan, 1887c: 584 (compiled).—Jordan and Bollman, 1889: 551 (Green Turtle Cay, Bahamas).—Jordan, 1890: 648 (Port Castries, St. Lucia).—Henshall, 1891: 379 (Card's Sound, Key West, Marco and Lemon Bay, Fla.).—Jordan and Fesler, 1893: 471-472, Pl. 37 (compiled; figure good).—Henshall, 1895: 217 (Key West).—Jordan and Evermann, 1896: 384 (compiled).—Smith, 1896: 176 (observed in Biscayne Bay).—Brice, 1898: 282 (compiled).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Jordan and Evermann, 1898: 1297-1299; 1900: Pl. 204, Fig. 530 (compiled; figure good).—Fowler, 1900: 119 (Port Antonio, Jamaica).—Evermann and Kendall, 1900: 77 (compiled).—Evermann and Marsh, 1900: 187-188, Fig. 52 (compiled; Puerto Real, Puerto Rico; figure good).—Evermann and Goldsborough, 1902: 153 (Cozumel, Yucatan).—Jordan and Thompson, 1905: 242 (Tortugas).—Nichols, 1912: 188 (observed at Havana and Cienfuegos, Cuba).—Starks, 1913: 46 (Natal, Brazil and along coast of Brazil).—Fowler, 1915a: 249 (Palm Beach, Fla.); 1915c: 535 (Trinidad).—Ribeiro, 1915: 377 (characters, range; compiled).—Longley, 1916: 210 (feeding habits).—Jordan and Evermann, 1916: 424, photograph (compiled; excellent photograph).—Fowler, 1917a: 132 (Colon, Panama).—Longley, 1918: 84 (in

- photograph with *H. sciurus*).—Ribeiro, 1918: 106 (synonymy).—Fowler, 1919: 147 (Kingston, Jamaica).—Metzelaar, 1919: 78 (compiled; Curaçao).—Nichols, 1921: 23 (Turk Island, Bahamas).—Longley, Schmitt and Taylor, 1925: 230 (Tortugas).—Meek and Hildebrand, 1925: 539-540 (compiled; Atlantic coast of Panama).—Borodin, 1928: 20 (Caribbean Sea).—Gudger, 1929: 181 (color).—Nichols, 1929: 271-272, Fig. 143 (compiled; figure poor; San Juan).—Fowler, 1929: 638 (compiled).—Jordan, Evermann and Clark, 1930: 329 (compiled).—Parr, 1930: 57 (Turks Island).—Fowler, 1941: 161 (compiled).—Galloway, 1941: 119 (Key West).—Longley and Hildebrand, 1941: 124, Pl. 13, Figs. 1-2, Pl. 14, Fig. 1 (behavior; descriptions of color phases; Tortugas).—Reed, 1941: 76 (name in list of Texas game fishes, possible misidentification).—Fowler, 1942a: 75 (observed in Cuban collection); 1944: 446, 466 (compiled); 1945: 305-306 (compiled; Geiger Key, Key West).—Breder, 1948b: 178 (compiled).—Baughman, 1950: 250 (compiled).—Roig, 1950: 180 (compiled).—Arnov, 1952: 428-430 (compiled).—Fowler, 1952: 96 (Port-Au-Prince).—LaMonte, 1952: 108-109 (compiled).—Ekman, 1953: 35 (name only).—Fowler, 1953: 63 (Cartagena, Colombia).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 87 (compiled).
- Haemulon acutum* Poey, 1860: 180-181 (description; Cuba), 354 (compiled); 1861a: 369 (compiled); 1868: 315-316 (redescription); 1875: 119 (compiled).—Bean and Dressel, 1884: 158 (Jamaica).—Jordan and Swain, 1884a: 294-296 (synonymy, characters; incorrectly includes *H. brevirostrum* Günther = *scudleri* in synonymy).—Jordan, 1886: 42 (Havana); 1887a: 878 (name only).—Diaz, 1893: 92 (compiled).
- Haemulon serratum* Poey, 1860: 181 (brief description; Cuba); 1861a: 369 (compiled); 1868: 317 (compiled); 1875: 120 (compiled).—Diaz, 1893: 92 (compiled; allied with *D. chromis* Broussonnet).
- Haemulon albidum* Poey, 1860: 181-182 (description; Cuba); 1861a: 369 (compiled); 1868: 316 (redescription; species dubia on p. 316 and 317 are also *parrai*); 1875: 120 (compiled; Cienfuegos, Cuba).—Diaz, 1893: 92 (compiled).
- Anarmostus serratus*, Scudder, 1863: 12 (referred to *serratum* Poey).
- Haemulon jeniguano* species dubia Poey, 1868: 318 (young *parrai*).
- Haemulon parrae*, Poey, 1875: 121 (emended name; referred to *caudimacula* Cuvier).—Bean and Dresel, 1884: 158 (synonymy; Jamaica).—Jordan, 1884a: 126 (Key West); 1884c: 78, 80 (compiled).—Jordan and Swain, 1884b: 292-293 (in part; incorrectly synonymized with *H. canna* Cuvier, *notatum* Poey, *retrocurrens* Poey and *continuum* Poey = *bonariense*).—Diaz, 1893: 93 (compiled).
- Diabasis fremebundus*, Bean, 1883: 57 (misidentification; Garden Key, Tortugas).
- Diabasis chromis*, Bean, 1883: 58 (Garden Key, Tortugas).—Goode and Bean, 1883: 238 (Gulf of Mexico).—Goode, 1888: 80 (name only).
- Haemulon macrostomum*, Jordan and Thompson, 1905: 242 (misidentification; based on record of Bean, 1883).
- Material examined*.—Florida: UMML 997 (5, 60.2-67.3); UMML 1400 (3, 60.2-85.5); UMML 1294 (1, 72.6); UMML 75 (1, 87.6); UMML 1959 (6, 87.9-129.5); UMML 340 (1, 88.1); UMML 3038 (2, 108.4-150.0);

UMML 3177 (2, 109.6-113.4); UMML 3386 (1, 138.0); UMML 4679 (2, 12.2-20.6); D de S 22 (1, 59.2); CRR-F-219 (1, 183.0); UMML 4533 (1); UMML 4802 (2); UMML 4167 (7); USNM 3093 (1); USNM 68423 (2); ANSP 90309 (3).

Western Bahamas: UMML 2941 (3, 58.7-90.0); UMML 2839 (2).

Jamaica: C-4-2059-1J (2, 49.4-70.3); C-4-2159-1J (1, 52.1).

Diagnosis.—Pored lateral-line scales 51 to 52, usually 52; caudal-peduncle scales 21 to 22, usually 22 (9-2-11); dorsal fin 11+1, 16 to 18, usually 17 or 18; anal fin 3, 8; pectoral fins 17; gill rakers 21 to 24, usually 22 or 23. Body silvery-white with bronze to gray stripes running along scale rows, those above lateral line formed by spots in center of scales. Soft dorsal, caudal, soft anal and pelvic fins dusky gray; pectoral fins light gray to chalky, scaled. Black blotch often present beneath free margin of preopercle. Juveniles with lateral stripe from behind eye to caudal peduncle. Separate, round caudal spot posterior to caudal base.

Description.—A moderate-sized species, mature adults average slightly larger than 200 mm in standard length. General body form is shown in Fig. 3a. The posterior margin of the upper jaw reaches to a point below the front of the eye lens. Preopercular serrations are not present in adults.

The dorsal fin includes twelve spines and the anal fin contains three. Fin-ray counts are given in Table 7.

The longitudinal scale rows immediately below the lateral line are oblique. Scale counts are given in Tables 8 and 9. The gill rakers are short and counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are graphed in Fig. 15.

Coloration.—The typical color pattern is shown in Fig. 3a. The stripes above the lateral line are formed by spots located in the center of the scales and follow the scale rows. In life the stripes are usually dark brown or dark gray, although they may appear black, bronze or yellow, depending on ecological conditions at the time of capture. The belly is dusky. The dorsal, anal, caudal and pelvic fins are chalky.

A black blotch is usually present beneath the free margin of the preopercle. The mouth is red within.

The peritoneum is black.

Juvenile pigmentation.—Juvenile specimens of *parrai* are illustrated in Figs. 8c-d, 9a-b. The caudal spot and lateral stripe appear simul-

taneously. The stripe and spot are not continuous except for very scattered, small melanophores. Except in very young stages of less than 18 mm in standard length, the caudal spot is round. The anterior edge of the spot barely spreads onto the caudal base and in most specimens is limited to the area posterior to the edge of the hypural plate.

Comparisons.—The relationships of *parrai* are with *flavolineatum* and *carbonarium*. Adults of these species are easily separated when alive or fresh by color patterns. The pectoral fins of mature *parrai* are scaled; those of the other species of *Haemulon* are naked. The scales below the lateral line in *flavolineatum* are much larger than those above. The eye of *carbonarium* is larger than that of *parrai* and dorsal fin-ray counts are of use in distinguishing these species.

Juveniles of *parrai* resemble those of *sciurus* and *flavolineatum*. The uninterrupted lateral stripe which terminates in the caudal spot characterizes *sciurus* from *parrai*. The lateral stripe in both *parrai* and *flavolineatum* does not enter the caudal spot. The caudal spot of the latter species is oval and equally distributed on both sides of the caudal base. The caudal spot of *parrai* is round and barely touches the caudal base.

Distribution and ecology.—The range of *parrai* extends from the Miami area of Florida through the West Indies to Brazil and along the Central American coast to the southern Gulf of Mexico. In Florida and Bahamian waters this species occurs from the shore to the outer reefs or the edge of deeper water. The young are frequently found in shallow, inshore waters, especially in grass beds.

Remarks.—This species was described by Desmarest as *Diabasis parra*, a patronym honoring Don Antonio Parra, an early Cuban naturalist. The name *parra* is here treated according to Article 14 of the International Rules of Zoological Nomenclature and takes the ending *-i*.

Haemulon flavolineatum (Desmarest)

FRENCH GRUNT

Figs. 3b, 9c-d, 10a-b, Tables 1-10

Diabasis flavolineatus Desmarest, 1823: 35-40, Pl. 2, Fig. 1 (original description; type locality: Cuba).

Haemulon heterodon Cuvier, 1829: 176 (no definition); in Cuvier and Valenciennes, 1829: 235-236, Pl. 121 (description; Martinique; figure in color, excellent); 1834: 156, Pl. 21, Fig. 3 (name; figure

- of head only); 1836: 84 (name only).—Guichenot, 1843: 180 (redescription).—Storer, 1846: 75 (compiled).—Poey, 1866: 309 (synonymy).
- Haemulon xanthopterum* Cuvier, in Cuvier and Valenciennes, 1829: 234-235 (description; Martinique).—Storer, 1846: 74 (compiled).—Günther, 1859: 312-313 (characters; skeletal description; incorrectly referred to *H. bonariense*).—Goode, 1880: 9 (Bermuda).—Jordan, 1887b: 536 (type not seen).
- Haemulon flavo-lineatum*, Poey, 1861a: 369 (emended name; compiled); 1868: 318 (synonymy; compiled).
- Anarmostus flavolineatus*, Scudder, 1863: 12 (compiled).
- Haemulon xanthopterum*, Cope, 1871: 471 (emended spelling; compiled; St. Croix).
- Haemulon flavolineatum*, Poey, 1875: 119 (compiled).—Jordan, 1884a: 126 (Key West); 1884c: 78 (name only).—Jordan and Swain, 1884b: 305-307 (compiled; incorrectly synonymized with *H. canna* Cuvier and *H. bonariense* Cuvier).—Jordan 1886: 42 (Havana); 1887a: 878 (name only); 1887c: 584 (compiled).—Bean, 1890: 205 (Cozumel).—Jordan, 1890: 648 (Port Castries, St. Lucia).—Diaz, 1893: 92 (compiled).—Jordan and Fesler, 1893: 476, Pl. 42 (compiled; figure mislabeled *H. rimator*).—Henshall, 1895: 217 (Key West).—Jordan and Evermann, 1896: 384 (compiled).—Brice, 1898: 282 (name only).—Jordan and Evermann, 1898: 1306-1307 (compiled).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Fowler, 1900: 119: 119 (Port Antonio, Jamaica).—Evermann and Kendall, 1900: 78 (compiled).—Evermann and Marsh, 1900: 191-192 (compiled; young from Puerto Rico).—Barbour, 1905: 123 (Harrington Sound, Bermuda).—Bean, 1905: 308 (Nassau and Abaco, Bahamas).—Jordan and Thompson, 1905: 242 (Tortugas).—Bean, 1906: 57 (Bermuda).—Blosser, 1909: 298 (St. Croix, Virgin Islands).—Fowler, 1915c: 535 (compiled).—Ribeiro, 1915: 376-377 (compiled).—Jordan and Evermann, 1916: 427-428 (compiled; excellent color description).—Longley, 1916: 211 (Tortugas, Fla.).—Fowler, 1917a: 132 (Colon, Panama).—Ribeiro, 1918: 105-106 (synonymy).—Fowler, 1919: 144, 150 (compiled; Fortune Island, Bahamas).—Metzelaar, 1919: 80 (Curacao; Bonaire; St. Eustatius; St. Martin; Surinam).—Nichols, 1921: 23 (Turks Island, Bahamas).—Fowler, 1923: 30 (Miami).—Evermann and Seale, 1924: 32 (Lesser Antilles).—Breder, 1925: 154 (Caledonia Bay, Panama).—Meek and Hildebrand, 1925: 531-532, Pl. 53 (Atlantic coast of Panama).—Breder, 1927: 47 (no locality data).—Beebe and Tee-Van, 1928: 158, Fig. on p. 158 (Port-Au-Prince Bay, Haiti).—Fowler, 1928: 453, 460, 464, 470 (Key West; Port-Au-Prince market, Haiti; Guanica, Puerto Rico; St. Lucia, British West Indies).—Nichols, 1929: 274-275, Fig. 146 (compiled).—Townsend, 1929: 329, Fig. 311 (color changes; excellent photographs).—Fowler, 1930a: 273 (Grenada, British West Indies); 1930b: 148 (Colon, Panama; Bermuda; Jamaica).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Manter, 1930: 338 (as host of trematodes).—Parr, 1930: 54 (Cat Island, Rum Cay, Crooked Island, West Caicos Island, and Turks Island, Bahamas).—Fowler, 1931: 399 (Gasparee Island, Monos Island, Trinidad).—Beebe and Tee-Van, 1933b: 152-

153, Fig. on p. 152, photograph, opposite p. 150 and 156 (compiled: figure and photographs excellent).—Fowler, 1937: 311 (Haiti); 1941: 161 (compiled).—Galloway, 1941: 119 (Key West).—Longley and Hildebrand, 1941: 127 (ecological notes; color observations; Tortugas).—Fowler, 1942b: 11 (Bonacca Island, Honduras); 1944: 107-108, Pl. 12; 446, 467 (Courtown Keys, Bahamas; compiled); 1945: 306 (compiled; Key West and Pompano Beach); 1947: 4 (Nassau and Lyford Cay, New Providence, Bahamas).—Breder, 1948b: 177, Fig. on 177 (compiled: figure poor).—Schultz, 1949: 135 (compiled).—Arnov, 1952: 426-428 (compiled).—Fowler, 1952: 95 (compiled).—LaMonte, 1952: 110, Pl. 45, top (compiled; figure good).—Fowler, 1953: 63 (Cartagena, Colombia).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 87 (compiled).

Haemulum xanthopteron, Goode, 1877a: 5 (emended spelling; Bermuda); 1877b: 292 (compiled).—Bean, 1881: 96 (Bermuda).

Haemulon fremebundum Goode and Bean, 1880: 340-341 (description; Clearwater Harbor, Fla.; based on young spec.).—Jordan and Swain, 1884b: 297-298 (compiled; incorrectly synonymized with *H. macrostomum*).—Jordan, 1885a: 548 (compiled); 1887a: 878 (name only); 1887c: 584 (name only).

Diabasis fremebundus, Goode and Bean, 1883: 238 (compiled).—Jordan and Gilbert, 1883c: 554 (compiled).

Haemulon ekmani Lönnberg, 1895: 658-660 (description; Cape Haitien, Haiti).

Haemulon flavolineatus, Fowler, 1929: 639 (emended name; compiled).

Haemulon macrostomum, Springer and Woodburn, 1960: 41 (compiled on record of *fremebundum*).

Material examined.—Florida: UMML 2856 (3, 68.4-80.4); UMML 2156 (3, 69.1-93.4); UMML 3174 (4, 74.4-101.5); UMML 291 (2, 80.8-91.9); UMML 837 (1, 100.4); UMML 2406 (2, 116.0-138.1); UMML 3225 (2, 122.6-139.0); UMML 1402 (1, 10.5); UMML 4653 (1, 18.9); UMML 2584 (1, 29.9); UMML 343 (1, 49.1); UMML 3638 (4); UMML 4680 (3); USNM 23628 (2, 46.9-49.8), syntypes of *H. fremebundum* Goode and Bean; CRR-F-120 (1, 120.4).

Western Bahamas: UMML 2945 (6, 51.9-87.9); UMML 578 (3, 73.5-112.0); CRR-BWI-21 (5).

Jamaica: C-4-2159-2J (2, 70.8-75.1).

Diagnosis.—Pored lateral-line scales 47 to 50, usually 48 or 49; caudal-peduncle scales 22 (9-2-11); dorsal fin 11+1, 14 to 15; anal fin 3, 8; pectoral fins 16 to 17, usually 16; gill rakers 22 to 24, usually 23. Scales below lateral line larger than those above. Body yellow above, cream to white on belly, with dark to reddish-brown and yellow stripes. Dorsal-fin membranes yellow; soft dorsal, caudal, soft anal and pelvic fins light yellow to chalky; pectoral fins chalky. Black blotch beneath free margin of preopercle. Juveniles with lateral stripe from behind eye to caudal peduncle. Separate, oval-shaped caudal spot centered over caudal base.

Description.—A moderate-sized species; mature adults average between 150 and 175 mm in standard length. General body form and pattern are shown in Fig. 3b. The posterior margin of the upper jaw reaches a point beneath the anterior margin of the lens of the eye. The preopercle is slightly serrated from the angle throughout its vertical length in adults.

The dorsal fin contains twelve spines and the anal fin includes three. Fin-ray counts are given in Table 7.

The scales below the lateral line are larger than those above. Longitudinal scale rows below the lateral line are oblique. Scale counts are shown in Tables 8 and 9. Gill rakers are short and counts are given in Table 10.

Morphometric data are provided in Tables 1-6 and eye length-standard length relationships are shown in Fig. 15.

Coloration.—The color pattern of *flavolineatum* is shown in Fig. 3b. In life the lighter areas are bright yellow, the darker areas reddish-brown to dark brown. The belly is cream-colored to yellow. The spinous dorsal-fin membranes are yellow. The soft dorsal, caudal, anal, and pelvic fins are light yellow to chalky. The pectoral fins are chalky.

A black blotch is present beneath the free margin of the preopercle. The mouth is red within.

The peritoneum is black.

Juvenile pigmentation.—Juvenile pigmentation is shown in Figs. 9c-d, 10a-b. The caudal spot is present earlier in life in *flavolineatum* than in any other species of *Haemulon*. At 8 mm in standard length, melanophores are concentrated on both sides of the caudal base. At 10 mm in standard length melanophores of the lateral stripe appear. As growth continues the caudal spot becomes oval-shaped and is centered over the caudal base. The lateral stripe does not enter the spot except for a few, light melanophores. When the spot is fully formed, the larger scales below the lateral line are formed in oblique, longitudinal rows.

Comparisons.—*H. flavolineatum* is related to *parrai* and *carbonarium*. Adult specimens of *flavolineatum* can easily be separated from all other species by the larger scales below the lateral line.

Juvenile specimens are most often confused with those of *aurolineatum* because of strong similarities in shape and position of the lateral stripe and caudal spot. Two methods will readily separate

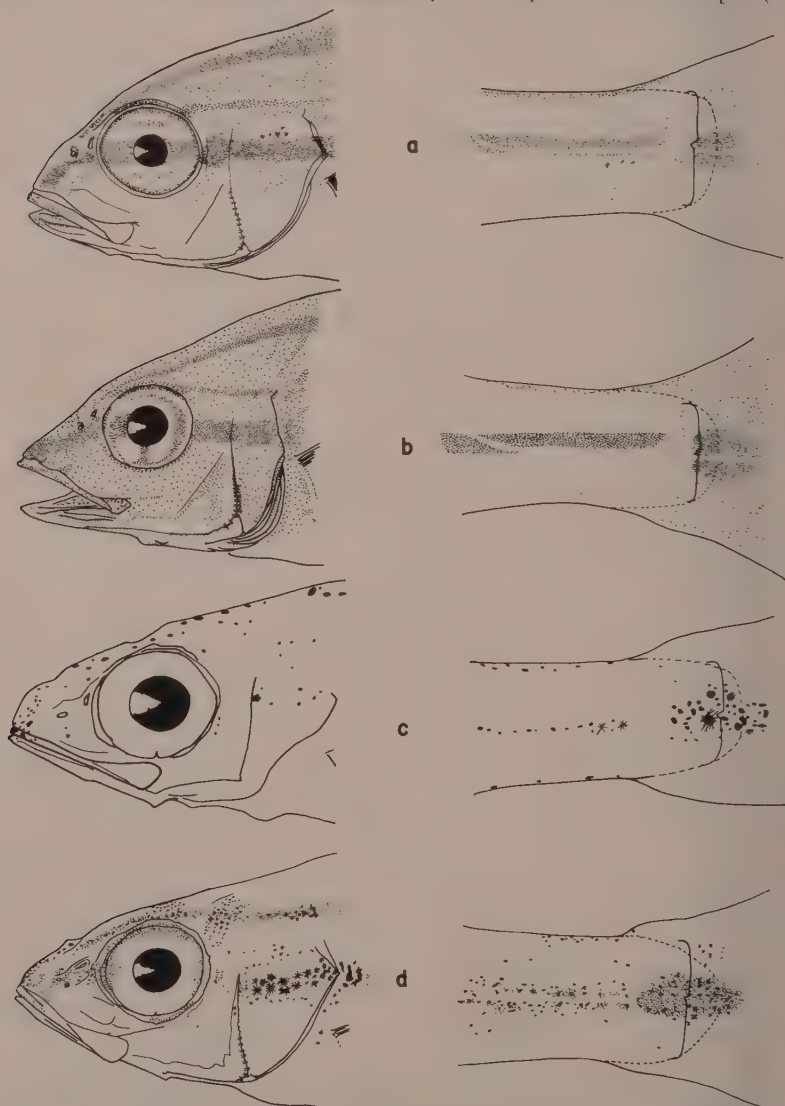


FIGURE 9. *Haemulon parrai*: a—UMML 2292, southern Florida, 29.6 mm standard length. b—UMML 6003, southern Florida, 59.2 mm standard length. *H. flavolineatum*: c—UMML 1402, southern Florida, 10.5 mm standard length. d—UMML 4653, Florida Keys, 18.9 mm standard length.

these two forms. Scaled specimens of *flavolineatum* under directional lighting will show the longitudinal scale rows to be noticeably oblique while those of *aurolineatum* parallel the long axis of the body. Microscopic examination of scales will show those of *flavolineatum* to be larger below the lateral line while those of *aurolineatum* will be the same size on both sides of the lateral line. The second method is counting dorsal spines. Those of *flavolineatum* number twelve while *aurolineatum* has thirteen.

Distribution and ecology.—*H. flavolineatum* occurs from the Miami area of southern Florida south through the West Indies to Brazil and along the Central American coast to the southern Gulf of Mexico. It is recorded from Bermuda.

It is one of the most abundant inshore fishes in Florida and the Bahamas. This species is found from the shore out to the edge of deeper water. Young individuals are often collected near shore over grass beds and in yacht basins. They are especially abundant on the outer reefs where they school with juveniles of *aurolineatum*.

Haemulon carbonarium Poey

CAESAR GRUNT

Figs. 3c, 10c, Tables 1-10

Haemulon carbonarium Poey, 1860: 176-177 (original description; type locality: Cuba); 1861a: 369 (compiled); 1868: 318 (compiled); 1875: 118 (compiled).—Jordan and Swain, 1884b: 298-299 (characters, color description; compiled).—Jordan, 1886: 42 (Havana); 1887c: 584 (compiled).—Diaz, 1893: 91 (compiled).—Jordan and Fesler, 1893: 472-473 (range; compiled).—Jordan and Evermann, 1896: 384 (compiled); 1898: 1300-1301 (redescription from holotype).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Evermann and Marsh, 1900: 188-189 (compiled; observed in collection from San Geromino, Puerto Rico).—Barbour, 1905: 122 (off Hungry Bay, Bermuda).—Bean, 1905: 308 (Nassau, Bahamas).—Bean, 1906: 57 (Bermuda; compiled).—Ribeiro, 1915: 378 (compiled).—Jordan and Evermann, 1916: 425 (compiled; good life color description).—Ribeiro, 1918: 106 (compiled).—Metzelaar, 1919: 78 (Curacao).—Longley, 1922: 171 (Tortugas; observed).—Evermann and Seale, 1924: 32 (Barbados).—Meek and Hildebrand, 1925: 537 (compiled; Atlantic coast of Panama).—Breder, 1927: 47 (name; no data).—Gudger, 1929: 181 (compiled; Tortugas).—Nichols, 1929: 272 (compiled; observed in San Juan, Puerto Rico).—Fowler, 1929: 639 (compiled; Key West).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Parr, 1930: 55-57, Fig. 10 (Eleuthera Island, Rum Cay and Turks Island, Bahamas; excellent color description; figure fair).—Beebe and Tee-Van, 1933b: 154-155, Fig. on p. 155 (compiled; figure poor).—Howell-Rivero, 1938: 198 (compiled).—

Fowler, 1941: 161 (compiled).—Longley and Hildebrand, 1941: 124-125, Pl. 14, Fig. 1 (Tortugas).—Fowler, 1942a: 75 (observed in Cuban collection); 1944: 446, 466 (compiled).—Breder, 1948b: 178 (compiled).—Roig, 1950: 180 (name only).—Arnov, 1952: 425-426 (compiled).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 87 (compiled).

Material examined.—Florida: CRR-F-142 (24, 134.8-204.5); ANSP 90308 (4, 162.4-215.6).

Western Bahamas: UMML 2372 (1, 182.2); ANSP-Chaplin Bahamas Program, sta. 223 (1, 109.0); ANSP-Chaplin Bahamas Program, sta. 205 (2).

Cuba: USNM 76977 (1, 223.3; holotype).

Puerto Rico: UMML 2170 (1, 192.4).

Netherlands Antilles, St. Martin: UMML 5588 (1, 51.4).

Bermuda: USNM 178396 (5, 26.1-36.2).

Diagnosis.—Pored lateral-line scales 49 to 50; caudal-peduncle scales 22 (9-2-11); dorsal fin 11+1, 15 to 16, usually 15; anal fin 3, 8; pectoral fins 16 to 17, usually 17; gill rakers 23 to 25. Eye large. Body silvery-white with black and bronze stripes; stripes below eye in blotched pattern. Fins dark grey to black. Black blotch often present beneath free margin of preopercle. Juveniles with lateral stripe from behind eye to caudal peduncle. Separate, large, rectangular-shaped caudal spot with rounded edges centered over caudal base.

Description.—A moderately large species, mature adults average over 200 mm in standard length. The general body form and pattern are shown in Fig. 3c. The posterior margin of the upper jaw reaches a point below the anterior third of the lens of the eye to the center of the eye. The preopercle is not serrated in adult specimens.

The dorsal fin includes twelve spines and the anal fin contains three. Fin-ray counts are provided in Table 7.

The longitudinal scale rows immediately below the lateral line are approximately parallel to the long axis of the body. Scale counts are given in Tables 8 and 9. The gill rakers are short and the total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are shown in Fig. 17.

Coloration.—Color observations are taken from the specimen photographed in Fig. 3c. The body is silvery-gray. The darker stripes are bronze to bright yellow in life. The belly is dusky gray. Conrad Limbaugh (personal communication) reports seeing *carbonarium* with black bellies in the Bahamas.

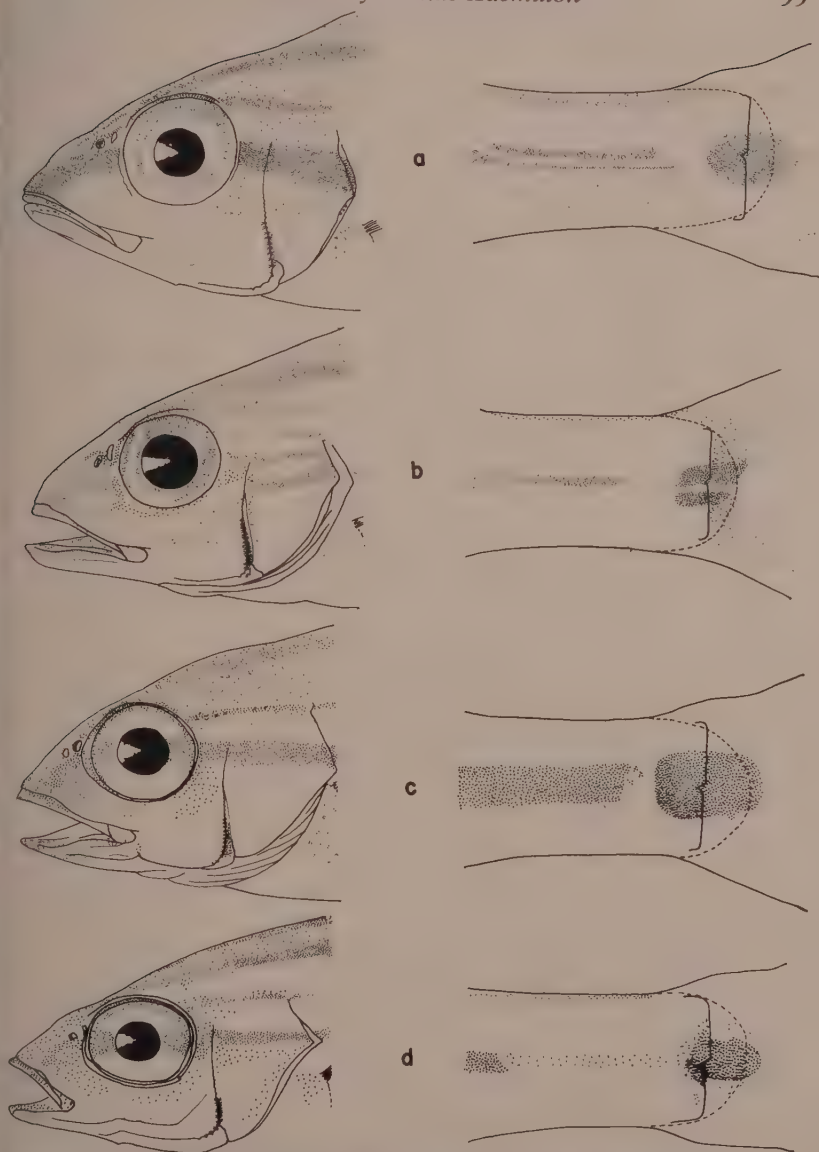


FIGURE 10. *Haemulon flavolineatum*: a—UMML 2584, western Bahamas, 29.9 mm standard length. b—UMML 343, Florida Keys, 49.1 mm standard length. *H. carbonarium*: c—UMML 5588, Netherlands Antilles, 51.4 mm standard length. *H. bonariense*: d—USNM 148672, Panama, 29.5 mm standard length.

The head is steel-blue with bronze stripes from the snout to behind the eye, those below the eye forming a blotched pattern. The chin is white to dusky gray and the upper and lower jaws are dusky gray. A black blotch is present beneath the free margin of the preopercle. The mouth is light red within.

The dorsal fin is black with bronze on the membranes between the spines and along the base of the soft dorsal. The anal fins are dusky gray to black with white spines. The caudal fin is dark gray to black with a bronze posterior margin. Pectoral and pelvic fins are dusky to dark gray or black.

The peritoneum is black.

Juvenile pigmentation.—The juvenile pattern is shown in Fig. 10c. Although the specimen figured is 51 mm in standard length, individuals as small as 26 mm in standard length show the same pigmentation pattern. The caudal spot is more or less rectangular with rounded edges, centered over the caudal base. The lateral stripe is separated from the spot. The caudal spot is large.

Comparisons.—*H. carbonarium* is related to *parrai* and *flavolineatum*. Relationships and comparisons are discussed in the account of *parrai*.

Mature adults could be confused with those of *macrostomum*. The latter species has a longer upper jaw as shown in Table 6. The eye of *carbonarium* is larger than that of *macrostomum*. Gill-raker counts and fin-ray counts are also useful in distinguishing these species.

Juvenile specimens of *carbonarium* show similarities to those of *macrostomum*. Young individuals of the latter species are shown in Figs. 11c-d, 12a. The shape of the caudal spot is quite different between the two species. The lateral stripe, the melanophore concentrations of the head and the caudal spot of *macrostomum* are black and appear heavy. Those of *carbonarium* are dark gray, often turning dark brown with long periods of preservation.

Distribution and ecology.—This species occurs from the Florida Keys and Bahamas through the West Indies to Brazil and northward along the Central American coast to the southern Gulf of Mexico. It is recorded from Bermuda.

Preference for clear water is shown by *carbonarium*. Of the species of *Haemulon* that occupy this type of environment, this is the only species that is known to enter tidal creeks and boat basins along the Florida Keys in periods of relatively calm weather.

Haemulon album Cuvier

MARGATE

Fig. 4a, Tables 1-10

Perca marina gibbosa cinerea Catesby, 1743: 2, Pl. 2 (brief description; Bahamas).—Jordan, 1884b: 190-191 (identified with *Haemulon gibbosum* Bloch and Schneider).

Perca gibbosa Walbaum, 1792: 348 (based on Catesby's figure; not of Linnaeus).

Perca chrysoptera Gmelin, 1788: 1314 (in part; misidentification).

Calliodon gibbosus, Bloch and Schneider, 1801: 313 (compiled).

Haemulon album Cuvier, in Cuvier and Valenciennes, 1829: 241-242 (original description; type locality: St. Thomas, Virgin Islands).—Guichenot, 1843: 180 (name only).—Storer, 1846: 75 (brief description, poor).—Günther, 1859: 311 (characters; Jamaica).—Poey 1866: 310-311 (compiled); 1868: 312-315 (brief description based on correspondence with Guichenot and specimen from Cayo Hueso, Cuba. Species dubia on p. 315 probably also *album*); 1875: 119 (compiled); 1883: 118 (Key West).—Diaz, 1893: 92 (compiled).—Jordan and Fesler, 1893: 469-480, Pl. 35 (characters; range; figure good).—Henshall, 1895: 217 (Key West).—Jordan and Evermann, 1896: 384 (compiled).—Brice, 1898: 282 (origin of common name; habitat note).—Jordan and Evermann, 1898: 1295-1296; 1900: Pl. 203, Fig. 528 (characters; synonymy; figure good).—Jordan and Rutter, 1898: 110 (Kingston, Jamaica).—Evermann and Kendall, 1900: 77 (compiled).—Evermann and Marsh, 1900: 185-186, Pl. 24 (compiled; Puerto Rico; figure in color showing dark phase, good).—Bean, 1905: 307 (Bahamas).—Jordan and Thompson, 1905: 242 (compiled; Tortugas).—Bean, 1906: 58 (compiled; Bermuda).—Nichols, 1912: 188 (Havana).—Ribeiro, 1915: 379-380 (compiled).—Jordan and Evermann, 1916: 422-423, photograph opp. p. 422 (compiled; photograph excellent).—Ribeiro, 1918: 107 (compiled).—Fowler, 1919: 150 (Grand Inagua; Nassau).—Metzelaar, 1919: 76-77 (compiled; St. Martin).—Nichols, 1921: 23 (Turks Island, Bahamas; compiled).—Mowbray, 1924: 148 (color illustr., figure excellent).—Meek and Hildebrand, 1925: 540 (compiled; not recorded from Panama).—Fowler, 1928: 470 (St. Lucia, British West Indies).—Nichols, 1929: 269-270, Fig. 140 (compiled; figure fair).—Fowler, 1929: 638 (New Providence, Bahamas, Santo Domingo, Jamaica).—Jordan, Evermann and Clark, 1930: 329 (compiled).—Parr, 1930: 57-58, Fig. 11 (Green Cay, Nassau, Bahamas; figure poor).—Beebe and Tee-Van, 1933b: 155-156, Fig. p. 155 (compiled).—Breder, 1934: 59 (Grassy Creek and off Fresh Creek, Andros, Bahamas).—Beebe, 1935: 318 (Haiti; compiled).—Fowler, 1941: 161 (Brazil; compiled).—Galloway, 1941: 119 (Key West, possible misidentification).—Longley and Hildebrand, 1941: 124-125, Pl. 14, Fig. 1 (ecological and color notes; Tortugas; excellent photograph).—Fowler, 1942a: 75 (Havana); 1944: 86-87, 448, 466 (compiled; Roncador Bank, 13°N, 80°W; Bahamas, compiled).—Breder, 1948b: 179, illustr. (compiled).—Fowler, 1950: 88 (St. Andrews Island, West Indies).—Roig, 1950: 180 (name only).—Arnov, 1952: 423-425 (compiled).—

- Fowler, 1952: 96 (compiled).—LaMonte, 1952: 109, Pl. 43 top (compiled; figure listed as margate is not *H. album* but *Anisotremus surinamensis*).—Fowler, 1953: 63 (compiled).—Briggs, 1958: 279 (range; habitat).—Duarte-Bello, 1959: 87 (compiled).
- Haemulon microphthalmum* Günther, 1859: 306-308; (first complete description of this species; America; Pl. 17 never published).
- Diabasis albus*, Scudder, 1863: 12 (name only).—Goode and Bean, 1883: 238 (name only).—Goode, 1888: 80 (name only).
- Haemulon canna*, Poey, 1866: 309 (in part; misidentification).
- Haemulon chromis*, Poey, 1866: 311 (in part; misidentification).
- Haemylum chrysopterum*, Goode, 1876: 53-54 (in part; misidentification).
- Haemulon chrysopterum*, Goode, 1875a: 5 (misidentification; Bermuda).
- Haemulon gibbosum*, Bean and Dresel, 1884: 158 (Jamaica).—Jordan, 1884a: 126 (Key West); 1884c: 78 (name only).—Jordan and Swain, 1884b: 290-291 (incorrectly synonymized with *Perca chromis* Broussonet, *H. chromis* Cuvier and *H. chrysopterum* Cuvier; characters; compiled).—Jordan, 1886: 42 (Havana); 1887a: 878 (name only); 1887c: 584 (West Indies; compiled).
- Material examined.**—Florida: UMML 5328 (1, 535.7).
 Western Bahamas: UMML 2371 (1, 209.5); UMML 3354 (1, 406.9); ANSP-Chaplin Bahamas Program, sta. 339 (1, 131.4).
 Eastern Bahamas: UMML 6004 (8, 92.0-166.1).

Diagnosis.—Pored lateral-line scales 49 to 52; caudal-peduncle scales 25 to 27, usually 26; dorsal fin 11+1, 16 to 17, rarely 17; anal fin 3, 7 to 8, usually 8; pectoral fins 18 to 19; gill rakers 21 to 23. Eye small. Body silvery-white. Pectoral fins chalky; other fins gray. Black blotch beneath free margin of preopercle absent. Large juveniles striped with spots in center of each scale above and below lateral line.

Description.—The largest of the species of *Haemulon*, mature adults average well over 500 mm in standard length. The general body form and pattern are shown in Fig. 4a. The posterior margin of the upper jaw reaches a point below the anterior margin of the eye. The preopercle is serrated in the adults.

The dorsal fin contains twelve spines and the anal fin includes three. Fin-ray counts are provided in Table 7.

The longitudinal scale rows immediately below the lateral line are oblique. Scale counts are given in Tables 8 and 9. The gill rakers of the first arch are short and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are shown in Fig. 17.

Coloration.—Two color phases are noted in *album*. The dark phase,

typical of specimens observed on reefs or over rocky areas, is shown in Evermann and Marsh, 1900: Pl. 24. In this phase the body is olive green with dark brown stripes which appear to be similar to the juvenile pattern characteristic of the species of *Haemulon*.

The other color pattern is illustrated in Fig. 4a. In this phase the body is silvery-white. The membranes of the spinous dorsal fin are white. The soft dorsal, caudal, anal, and pelvic fins are dusky gray. The pectoral fins are chalky with gray spines.

Juvenile pigmentation.—Juvenile specimens of less than 92 mm in standard length were not seen. However, the pattern at this size is considerably different from that of the adults. The back is a light brownish-gray, changing to white on the belly. Each scale row behind the head to the caudal peduncle and from the base of the dorsal fin almost to the pelvic fin origin appears to have undulating or oblique lines running through and with the scale row. These lines are formed by dark spots in the center of each scale.

Comparisons.—*H. album* is related to *bonariense*, *macrostomum* and *plumieri*. The caudal peduncle scale count separates *album* from these other species. The eye of *album* is smaller in relation to those of the related forms. Pigmentation and lateral-line scale counts of *bonariense*, the large mouth of *macrostomum* and the large scales above the lateral line in *plumieri* are of use in distinguishing these forms from *album*.

Large juveniles of *album*, as described above, are most easily confused with juveniles of *steindachneri*, *bonariense* and *parrai*. The stripes in *album* are composed of spots in the center of each scale while those of *steindachneri* and *bonariense* appear to be continuous pigment stripes passing through the scales. The absence of a dark, lateral stripe and caudal spot characteristic of juvenile *parrai* will separate this species from *album*.

Distribution and ecology.—The range of *album* extends from the Florida Keys and Bahamas through the West Indies to Brazil. It has not been recorded from the Central American coast although its presence there is suspected. This species is recorded from Bermuda.

H. album prefers clear water of the offshore reefs in Florida and inshore Bahamian waters. It is rarely encountered in Florida and when observed is usually in numbers of one or two. Large numbers are found schooling in the eastern Bahamas (John E. Randall and Walter A. Starck, II; personal communication).

Haemulon bonariense Cuvier

BLACK GRUNT

Figs. 4b, 10d, 11a-b, Tables 1-10

Haemulon canna Cuvier, in Cuvier and Valenciennes, 1829: 233 (brief description; Martinique; pre-occupied in genus *Haemulon*).—Günther, 1859: 311 (characters; Jamaica; Guatemala; Puerto Cabello, Venezuela).—Poey, 1861a: 398 (distinguishes *canna* Cuvier from *canna* Agassiz=*parra*); 1868: 314 (incorrectly placed with *H. album*).—Jordan, 1887b: 535 (compiled).

Haemulon bonariense Cuvier, in Cuvier and Valenciennes, 1829: 234 (original description; Buenos Aires).—Poey, 1868: 314 (incorrectly referred to *H. album*).—Jordan, 1887b: 536 (compiled); 1887c: 584 (compiled).—Jordan and Fesler, 1893: 470-471 (synonymy; range).—Jordan and Evermann, 1896: 384 (range; compiled); 1898: 1297 (characters, synonymy; compiled).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Evermann and Marsh, 1900: 187 (characters, synonymy, range; San Juan).—Bean, 1906: 58 (compiled).—Ribeiro, 1915: 380 (compiled).—Jordan and Evermann, 1916: 424 (range; color).—Ribeiro, 1918: 107 (compiled).—Metzelaar, 1919: 77-78, Fig. 25 (compiled; figure excellent; Schottegat; Curacao; Venezuela).—Longley, 1922: 171 (Tortugas; observed).—Meek and Hildebrand, 1925: 541-542, Pl. 54, Fig. 1 (compiled; Atlantic coast of Panama).—Beebe and Tee-Van, 1928: 160-161, Fig. on p. 160 (Port-Au-Prince market, Haiti; figure fair).—Borodin, 1928: 20 (Cuba).—Nichols, 1929: 271, Fig. 142 (compiled; figure fair).—Jordan, Evermann and Clark, 1930: 329 (compiled).—Fowler, 1931: 399 (La Brea and Harto Cut, Trinidad).—Beebe and Tee-Van, 1933b: 157 (compiled; Bermuda, "known . . . only from a questionable published record.").—Fowler, 1937: 311 (Haiti); 1939: 7 (Port-of-Spain, Trinidad); 1941: 161 (compiled).—?Longley and Hildebrand, 1941: 123-124 (Tortugas; observed, probably misidentified).—Fowler, 1942a: 75 (observed in Cuban collection); 1944: 466 (compiled); 1946: 7 (Port-of-Spain, Trinidad).—Schultz, 1949: 135 (compiled).—Fowler, 1950: 74 (Cayo Largo, Cuba; may be misidentified).—Arnov, 1952: 422-423 (compiled).—Fowler, 1952: 96, Fig. 21 (Port-Au-Prince, Haiti; figure good).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 87 (compiled).

Haemulon notatum Poey, 1860: 179-180 (description; Cuba); 1861a: 369 (compiled); 1868: 317 (brief additions to 1860 description); 1875: 120 (compiled).—Diaz, 1893: 92 (compiled).—Howell-Rivero, 1938: 198 (compiled).

Haemulon retrocurrans Poey, 1868: 236-238 (first complete description of this species; Cuba); 1875: 120 (compiled).

Haemulon continuum Poey, 1875: 120-121 (description; Cuba).—Diaz, 1893: 93 (compiled).

Haemulon parrae, Jordan and Swain, 1885: 292 (misidentification).

Material examined—Cuba: USNM 2695 (1, 126.2); USNM 24953 (1, 141.1).
Haiti: USNM 132551 (1, 151.2) ANSP 76354 (1, 102.5).

Jamaica: USNM 6766 (1, 162.3).

Martinique: USNM 178631 (1, 87.9).

Trinidad: ANSP 76234 (1, 115.0); USNM 34459 (1, 137.7).

West Indies: USNM 33258 (1, 179.5).

Panama: USNM 148672 (6, 29.7-69.9); USNM 81104 (3, 59.9-64.5); USNM 148670 (2, 63.1-67.7); USNM 81101 (6, 80.1-121.4); USNM 81100 (1, 35.5).

Honduras: USNM 34649 (1, 146.7).

Diagnosis.—Pored lateral-line scales 45 to 48, usually 46; caudal-peduncle scales 21 to 22, usually 22 (9-2-11); dorsal fin 11+1, 15 to 16; anal fin 3, 8 to 9, usually 8; pectoral fins 16 to 17, usually 17; gill rakers 20 to 23. Scales large. Preserved specimens silvery-white with gray to dark brown or black stripes on body above and below lateral line. Black blotch often present beneath free margin of preopercle. Juveniles with lateral stripe from behind eye to caudal peduncle, widely separated from caudal spot. Anterior third of caudal spot over caudal base expanded dorso-ventrally; remainder of spot tapered posterior to caudal base.

Description.—A moderate-sized species, mature adults average between 150 to 175 mm in standard length. The general body contours are shown in Fig. 4b. The posterior margin of the upper jaw reaches a point below the anterior edge of the lens of the eye. The preopercle is slightly serrated from the angle through about half of its vertical length.

The dorsal fin includes twelve spines and the anal fin contains three. Fin-ray counts are given in Table 7.

The longitudinal scale rows below the lateral line are oblique. The scales of this species are larger than in any other species of *Haemulon*. Scale counts are given in Tables 8 and 9. The gill rakers are short and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are shown in Fig. 15.

Coloration.—Living or freshly preserved material of *bonariense* was not seen. Preserved specimens have a series of dark brown to black stripes arranged as shown in Fig. 4b. The stripes are formed along the scale rows, the pigment crossing through each scale in the row. The remainder of the body is silvery-white. The dorsal, caudal, anal, and pelvic fins are dusky gray to black. The pectoral fins are colorless.

A black blotch is present beneath the free margin of the preopercle. The peritoneum is black.

Juvenile pigmentation.—The pattern of juvenile pigmentation is illustrated in Figs. 10d, 11a-b. The lateral stripe is widely separated from the caudal spot. The configuration of the caudal spot is quite different. The greater part of the spot lies posterior to the caudal base. That part in front of and on the caudal base is spread dorso-ventrally, causing the entire spot to appear to be constricted behind the caudal base. The dark stripes characteristic of the adults appear at about 55 mm in standard length.

Comparisons.—*H. bonariense* is related to *album*, *macrostomum* and *plumieri*. Adults are readily distinguished by the dark stripes on the body which remain in preservation. The lateral-line scale count is also useful in separating this species from related forms.

Adults can be distinguished from those of *parrai* by the presence of scaled pectoral fins in the latter species. The stripes in *parrai* are formed by pigment spots in the center of the scales above the lateral line. This is not the case with *bonariense*.

Juvenile stages of *bonariense* do not strongly resemble those of any other species of the genus. The wide separation of the peculiarly-shaped caudal spot from the lateral stripe does not occur in related forms. The spot could be confused with that in *aurolineatum* but the latter species is distinguished by the presence of thirteen dorsal spines as opposed to twelve.

Distribution and ecology.—The range of *bonariense* extends from Cuba through the West Indies to Brazil and along the Central American coast to the southern Gulf of Mexico. It is recorded from Bermuda. This species was reported from Florida by Longley (1922: 171) and again by Longley and Hildebrand (1941: 123-124) based on underwater observations. No specimens were collected and the record remains unconfirmed to the present time. A superficial resemblance to the color pattern of *bonariense* is shown by adults of *parrai* when observed underwater and, very possibly, Longley's record is a misidentification.

Little is known of the ecology of this species. Vladimir Walters seined several juveniles from grass beds in Panama. Field records indicate a preference for clear water.

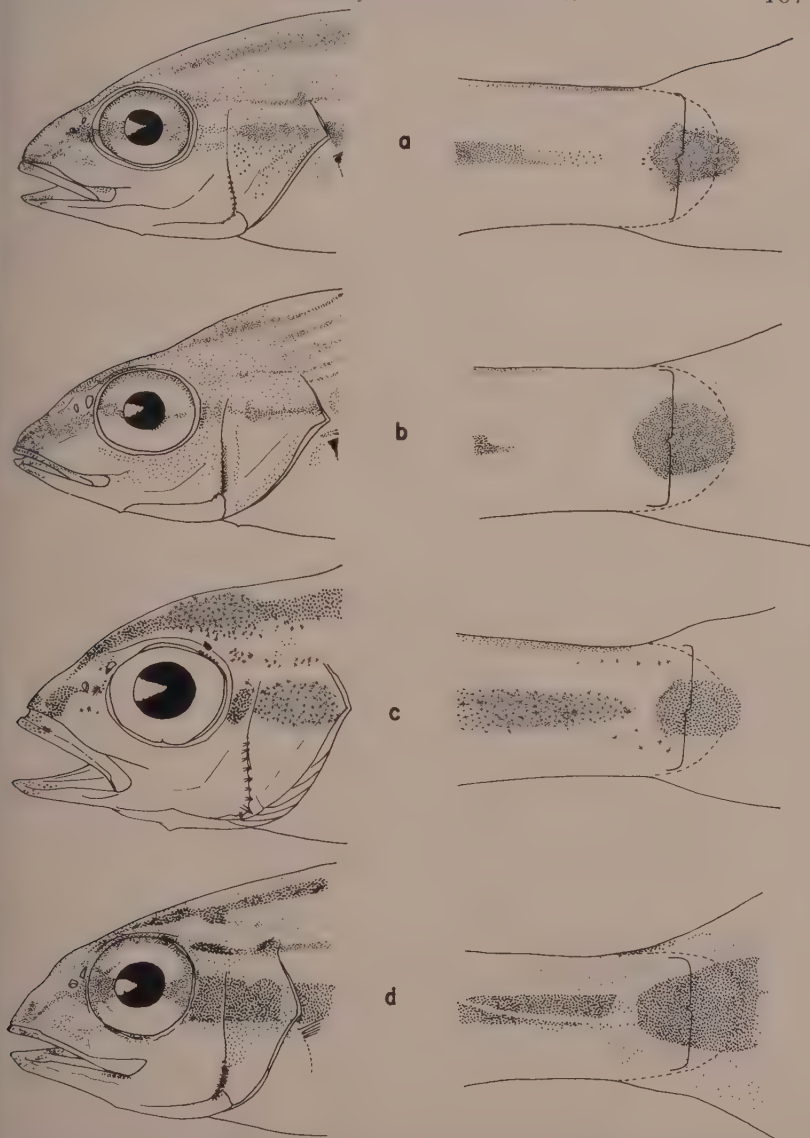


FIGURE 11. *Haemulon bonariense*: a—USNM 81100, Panama, 35.5 mm standard length. b—USNM 148672, Panama, 64.2 mm standard length. *H. macrostomum*: c—UMMZ 172944, Puerto Rico, 17.6 mm standard length. d—UMML 4654, Florida Keys, 38.4 mm standard length.

Haemulon macrostomum Günther

SPANISH GRUNT

Figs. 4c, 11c-d, 12a, Tables 1-10

Haemulon macrostoma Günther, 1859: 308-310 (original description; type locality: Jamaica); 1880: 9 (Bermuda).—Jordan and Swain, 1884b: 289 (compiled; incorrectly referred to *H. gibbosum* Linnaeus).—Jordan, 1887b: 536 (in part; specimens examined = *H. carbonarium*, fide Jordan); 1887c: 584 (compiled).—Jordan and Fesler, 1893: 470, Pl. 36 (compiled; incorrectly includes *H. fremebundum* Goode and Bean in synonymy).—Evermann and Bean, 1898: 244 (Indian River inlet, Fla.; questionable record).—Evermann and Kendall, 1900: 77 (compiled; incorrectly includes *H. fremebundum* in synonymy).—Fowler, 1915a: 249 (Palm Beach, Fla.); 1929: 638 (compiled); 1945: 305 (compiled; Key West; incorrectly includes *H. fremebundum* in synonymy).

Haemylum macrostoma, Goode, 1877a: 5 (Bermuda); 1877b: 292 (compiled).

Haemulon fremebundum, Bean and Dresel, 1884: 159 (misidentification; Jamaica).

Haemulon macrostomum, Jordan and Evermann, 1896: 384 (compiled).—Jordan and Rutter, 1898: 109 (Kingston, Jamaica).—Jordan and Evermann, 1898: 1296-1297; 1900: Pl. 204, Fig. 529 (compiled; incorrectly includes *H. fremebundum* in synonymy).—Evermann and Marsh, 1900: 186-187, Fig. 51 (characters; synonymy; compiled; color description; incorrectly includes *H. fremebundum* in synonymy).—Barbour, 1905: 122 (Hamilton, Bermuda).—Bean, 1906: 58 (compiled).—Longley, 1916: 210 (feeding habits).—Jordan and Evermann, 1916: 423-424, Fig. on p. 423 (compiled; figure fair).—Longley, Schmitt and Taylor, 1925: 230 (Tortugas).—Meek and Hildebrand, 1925: 535-536 (compiled; Atlantic coast of Panama; incorrectly includes *H. fremebundum* in synonymy).—Beebe and Tee-Van, 1928: 160, Fig. on p. 160 (Port-Au-Prince Bay, Haiti).—Fowler, 1928: 470 (St. Lucia, British West Indies).—Gudger, 1929: 180 (compiled; excellent color description).—Nichols, 1929: 270-271, Fig. 141 (compiled; figure fair).—Jordan, Evermann and Clark, 1930: 329 (compiled; incorrectly includes *H. fremebundum* in synonymy).—Beebe and Tee-Van, 1933b: 156, Fig. on p. 156 (compiled; figure poor).—Fowler, 1937: 311 (Haiti).—Galloway, 1941: 119 (Key West).—Longley and Hildebrand, 1941: 123, Pl. 12, Fig. 2 (ecological notes; figure excellent).—Reed, 1941: 76 (in list of Texas game fishes, possible misidentification).—Fowler, 1944: 467 (compiled).—Breder, 1948b: 178, Fig. on p. 178 (compiled; figure fair).—Baughman, 1950: 250 (compiled).—Buller, 1951: 15 (off southern U.S. coast, possible misidentification).—Arnov, 1952: 418-420 (compiled; incorrectly includes *H. fremebundum* in synonymy).—Fowler, 1952: 96 (compiled).—LaMonte, 1952: 108 (compiled).—Fowler, 1953: 63 (Cartegena, Colombia).—Erdman, 1956: 320, 321 (spawning).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 87 (compiled).—Springer and Woodburn, 1960: 41 (misiden-

tification based on record of *H. fremebundum*, Goode and Bean, 1880).

Haemulon chrysopterum Mowbray, 1915: 1298, Fig. on p. 1298 (not of Cuvier, 1829: 176; description; Key West; photograph excellent).

Haemulon mowbrayi Jordan and Evermann, 1927: 505 (to replace *H. chrysopterum* Mowbray, preoccupied).—Longley, 1932: 300 (compiled).—Breder, 1948b: 177 (compiled).

Material examined.—Florida: UMML 3224 (1, 150.7); UMML 3424 (1, 99.2); UMML 3640 (1, 60.3); UMML 5196 (4, 78.8-141.5); UMML 4654 (1, 38.4); ANSP 90011 (6, 229.5-278.2); CRR-F-142 (4, 109.5-297.3); CRR-F-156 (10, 229.6-296.6); UMML 1393 (1, 235.0).

Puerto Rico. UMMZ 172944 (1, 17.6); UMML 1880 (1, 204.5).

Virgin Islands: UMML 6002 (1).

Diagnosis. — Pored lateral-line scales 50 to 52, usually 51; caudal-peduncle scales 22 (9-2-11); dorsal fin 11 + 1, 15 to 17, usually 16; anal fin 3,9; pectoral fins 18, rarely 17; gill rakers 26 to 28. Mouth large. Soft dorsal fin high. Body silvery-white with dark brown to black stripes; yellow-green stripe along base of dorsal fin. Dorsal fin membranes yellow to yellow-orange; soft dorsal, caudal, soft anal and pelvic fins dark gray to black; pectoral fins chalky. Black blotch often present beneath free margin of preopercle. Juveniles with very dark stripe from behind eye to caudal peduncle. Separate wedge-shaped caudal spot posterior to caudal base.

Description. — A large species, mature adults average more than 250 mm in standard length. General body form is shown in Fig. 4c. The mouth is very large, the posterior margin of the upper jaw reaching a point below the center of the eye. The preopercle is not serrated in the adults.

The dorsal fin includes twelve spines and the anal fin includes three. Fin-ray counts are given in Table 7.

The longitudinal scale rows immediately below the lateral line are oblique. Scale counts are shown in Tables 8 and 9. The gill rakers are short and counts are given in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are shown in Fig. 17.

Coloration. — The typical life color pattern is shown in Fig. 4c. The lighter areas are white to bronze and the dark stripes are black. Below the base of the dorsal fin and above the first black stripe the back is greenish-yellow. The membranes of the spinous dorsal fin are

greenish-yellow as is the margin of the soft dorsal fin. The base of the soft dorsal, caudal, anal, and pelvic fins are dark gray to black. The pectoral fin is yellow to olive.

A black blotch is present beneath the free margin of the preopercle. The mouth is red within.

The peritoneum is black.

Juvenile pigmentation. — Juvenile pigmentation is shown in Figs. 11c-d, 12a. The melanophore concentrations of juvenile *macrostomum* cause the stripes and caudal spot to appear darker than in any other species of *Haemulon*. The lateral stripe and caudal spot are separated. At 30 mm in standard length the caudal spot acquires a characteristic wedge-shape which is retained until the adult pattern appears. The spot is very large.

Comparisons. — *H. macrostomum* is related to *album*, *bonariense* and *plumieri*. It differs in having a larger mouth, high soft dorsal fin and characteristic markings which do not fade in preservation. The large number of caudal peduncle scales characteristic of *album*, the prominent markings and low lateral-line scale count of *bonariense* and the large scales above the lateral line in *plumieri* are absent in *macrostomum*.

Young individuals of *macrostomum* differ from other species by the shape of the caudal spot and intense black of the body markings. The juveniles of a distantly related pomadasyid, *Anisotremus surinamensis*, resemble the pattern shown in *macrostomum* but the caudal spot in the former species is much larger and the dorsal fin is crossed between the fourth to sixth spines by a black or dark gray band which runs ventrally to the belly (Fig. 14).

Possible confusion between the young of *macrostomum* and *carbonarium* is resolved by the shape of the caudal spot. The markings of *carbonarium* are much lighter than those of *macrostomum*.

Distribution and ecology. — *H. macrostomum* ranges from the Florida Keys through the West Indies to Brazil and along the Atlantic coast of Panama. It is recorded from Bermuda.

This species prefers clear water and inhabits the reefs off the Florida Keys. The young are found only on the reefs and somewhat closer to shore during periods of calm weather.

Haemulon plumieri (Lacépède)

WHITE GRUNT

Figs. 5a, 12b-d, 13a, Tables 1-10

- Guabi coara brasiliensibus* Marcgrave, 1648: 163 (brief description; figure does not correspond with description).
- Perca marina capite striato* Catesby, 1743: 6, Pl. 6, top (brief description; no locality data: figure poor).—Jordan, 1884b: 192 (identified with *H. plumieri*).
- Perca formosa* Linnaeus, 1766: 488 (in part; brief description, confused with *Diplectrum formosum*; Carolina).—Walbaum, 1792: 337 (in part; compiled; based on Catesby's figure).—Bloch and Schneider, 1801: 90 (in part; based on Catesby's figure).
- Labrus plumierii* Lacépède, 1802: 480, Pl. 2, Fig. 2 (original description; based on drawing by Plumier, type locality: America).
- Haemulon formosum*, Cuvier, 1829: 175-176 (in part; allied to *P. formosa* Linnaeus, Catesby's figure, *L. plumierii* Lacépède and *Guaibi coara* Marcgrave); in Cuvier and Valenciennes, 1829: 230-232 (description; Martinique); 1836: 84 (in part; compiled).—Guichenot, 1843: 179 (compiled).—Storer, 1846: 73 (in part; compiled).—Günther, 1859: 305-306 (in part; synonymy, characters).—Poey, 1861a: 398 (in part; compiled).—Gill, 1862: 32 (compiled).—Poey, 1868: 464 (name only): 1873: 806 (range; listed as not of Linnaeus).—Uhler and Lugger, 1876: 105 (in part; compiled; mouth of Potomac River in marine waters).—Lönnerberg, 1894: 127 (Key West; Ozona, Hillsborough County; observed).
- Haemulon arcuatum* Valenciennes, in Cuvier and Valenciennes, 1833: 481-482 (description; Charleston, South Carolina).—Storer, 1846: 76 (compiled).—Gill, 1862: 32 (compiled); 1873: 806 (compiled).—Holbrook, 1875: 123-127, Pl. 17, Fig. 2 (characters; synonymy; compiled; internal anatomy, range; figure in color, good).—Goode, 1880: 113 (St. Augustine).—Bean and Dresel, 1884: 158 (Jamaica).—Goode and Bean, 1886: 207 (in part; may be *album*, fide Goode and Bean).—Bean, 1890: 204 (Cozumel).
- Labrus plumieri*, Cuvier, 1834: 156 (emended name; compiled).
- Hemulon formosum*, DeKay, 1843: 86-87, Pl. 20, Fig. 59 (in part; compiled; New York harbor).
- ?*Haemulon parae*, Castelnau, 1855: 10 (refers to *Acara pitanga* Marcgrave from Bahia; possibly misidentification).
- Haemulon arara* Poey, 1860: 177-178 (description; Cuba); 1861a: 369 (compiled); 1868: 318 (additions to description of 1860); 1875: 119 (compiled).—Diaz, 1893: 91 (compiled).—Howell-Rivero, 1938: 199 (synonymized with *plumieri*).
- Haemulon subarcuatum* Poey, 1861a: 369 (no definition); 1861b: 419 (description; Sagua la Grande, Cuba); 1868: 318 (color note); 1875: 119 (compiled).—Diaz, 1893: 92 (compiled).
- Haemylum formosum*, Scudder, 1863: 12 (allied with *formosum* Cuvier).
- Haemylum arara*, Scudder, 1863: 12 (allied with *arara* Poey).
- Haemulon formosum*, Cope, 1871: 470 (St. Croix; New Providence).
- Diabasis formosus*, Goode and Bean, 1883: 238 (Gulf of Mexico).—

- Jordan and Gilbert, 1883a: 276 (compiled; Pensacola); 1883c: 553 (in part; characters, synonymy, compiled).
- Diabasis plumieri*, Bean, 1883: 15, 58 (Key West; range).—Jordan and Gilbert, 1883b: 603-604 (compiled).—Goode, 1884: 398 (compiled; St. Augustine market); 1888: 79-80 (compiled).
- Haemulon plumieri*, Jordan, 1884a: 126 (Key West); 1884c: 78 (compiled).—Jordan and Swain, 1884a: 232 (Cedar Keys); 1884b: 303-305 (compiled).—Jordan, 1886: 42 (Havana); 1887a: 878 (name only); 1887c: 584 (compiled); 1890: 648 (Port Castries, St. Lucia).—Henshall, 1891: 379 (Key West).—Jordan and Fesler, 1893: 475, Pl. 39 (compiled; figure good).—Henshall, 1895: 217 (Key West).—Garman, 1896: 78 (Tortugas).—Jordan and Evermann, 1896: 384 (compiled).—Smith, 1896: 176 (observed in Biscayne Bay).—Brice, 1898: 281 (compiled; spawning).—Jordan and Rutter, 1898: 109 (Kingston).—Jordan and Evermann, 1898: 1304-1306; 1900: Pl. 205, Fig. 532 (compiled; figure good).—Evermann and Kendall, 1900: 78 (compiled).—Evermann and Marsh, 1900: 190-191, Fig. 54 (compiled; figure good).—Fowler, 1903: 331 (compiled; lower Biscayne Bay).—Bean, 1905: 308 (Nassau).—Jordan and Thompson, 1905: 242 (Tortugas).—Fowler, 1906: 98-99 (Marquesas).—Smith, 1907: 292-293, Fig. 130 (compiled; Cape Fear, North Carolina).—Jordan and Dickerson, 1908: 15 (Vera Cruz).—Blosser, 1909: 298 (St. Croix).—Nichols, 1912: 188 (seen at Havana).—Starks, 1913: 46 (Natal, Brazil).—Fowler, 1915b: 50 (Santo Domingo).—Ribeiro, 1915: 375-376 (compiled).—Jordan and Evermann, 1916: 426-427, photograph (compiled; excellent color description).—Longley, 1916: 210, 211 (feeding habits; Tortugas).—Fowler, 1917b: 23 (Virgin Islands).—Ribeiro, 1918: 105 (synonymy).—Fowler, 1919: 144 (compiled), 147 (Port Antonio, Jamaica), 150 (Nassau, Grand Inagua), 153 (compiled).—Metzelaar, 1919: 80 (compiled; Haiti).—Longley, 1920: Pl. 1, Fig. 2, Pl. 4, Fig. 2 (photographs).—Nichols, 1921: 23 (Turks Island).—Fowler, 1923: 22 (compiled).—Evermann and Seale, 1924: 33 (Barbados).—Mowbray, 1924: 132 (photograph).—Longley, Schmitt, and Taylor, 1925: 230 (Tortugas).—Fowler, 1926: 252 (Sand Key, Fla.).—Longley, 1927: Pl. 15, top (color photograph, poor).—Beebe and Tee-Van, 1928: 158-159, Fig. on p. 158 (Port-Au-Prince Bay, Haiti).—Fowler, 1928: 453 (Key West), 464 (Guanica, Puerto Rico), 470 (St. Lucia).—Hildebrand and Schroeder, 1928: 260 (compiled).—Gudger, 1929: 182, Pl. 2, Fig. 11 (compiled; arrangement of lateral line).—Nichols, 1929: 274, Fig. 145 (compiled; seen at Ponce, Puerto Rico).—Townsend, 1929: 336, Pl. 14 (color observations; figure shows color phases).—Fowler, 1929: 639 (compiled).—Burkenroad, 1930: 17 (sound production).—Jordan, Evermann and Clark, 1930: 330 (compiled).—Manter, 1930: 338 (as host for trematodes).—Parr, 1930: 55 (Miami; off New Providence).—Gregory, 1933: 247, Fig. 121 (figure fair).—Beebe and Hollister, 1935: 216 (observed, Union Island, Grenadines, British West Indies).—Pierce, 1936: 123-124 (rate of digestion).—Storey and Gudger, 1936: 647, Table 2 (killed by cold).—Fowler, 1937: 311 (Haiti).—Storey, 1937: 17 (mortality due to cold).—Fowler, 1941: 161 (compiled).—Longley and Hildebrand, 1941: 126-127, Pl. 14, Fig. 2, Pl. 15, Figs.

1-2 (feeding habits; color; photographs excellent).—Fowler, 1942a: 75 (seen in Cuban collection); 1944: 446, 467 (compiled); 1945: 202 (compiled), 305 (Punta Gorda and Key West), Fig. 268 (poor).—Breder, 1948a: 304 (observed at Bimini, Bahamas); 1948b: 177 (compiled).—Roig, 1950: 180 (compiled).—Buller, 1951: 15 (off southern U.S. coast).—Arnov, 1952: 432-433 (compiled).—Fowler, 1952: 95 (compiled).—LaMonte, 1952: 110, Pl. 44 (compiled; figure in color, good).—Fowler, 1953: 64 (Cartegena, Colombia).—Reid, 1954: 40-41, 77, Table 7 (Cedar Key; Grassy Key, off Cedar Key, Fla.).—Erdman, 1956: 320 (spawning).—LeDanois, 1957: 94 (excellent photograph).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 88 (compiled).—Springer and Woodburn, 1960: 41 (Maximo Point and Bird Key, Middleground, Tampa Bay).
Haemulon plumierii, Meek and Hildebrand, 1925: 532-533 (compiled; Atlantic coast of Panama).

Material examined.—Florida: UMML 1047 (2, 51.1-63.1); UMML 3286 (7, 64.4-97.1); UMML 2813 (2, 72.2-76.1); UMML 3149 (3, 77.4-103.3); UMML 3023 (2, 89.0-97.1); UMML 3169 (6, 91.4-158.2); UMML 3051 (1, 96.5); UMML 342 (1, 97.2); UMML 2657 (1, 121.8); UMML 2786 (2, 19.8-23.2); UMML 3639 (2, 35.6-42.5); CRR-F-112 (1, 173.0); UMML 5022 (2); UMML 3694 (10).

Puerto Rico: UMML 1752 (3, 105.7-165.9).

Diagnosis. — Pored lateral-line scales 48 to 51, usually 50 to 51; caudal-peduncle scales 22 (9-2-11); dorsal fin 11+1, 15 to 17, usually 16; anal fin 3, 8 to 9, usually 9; pectoral fins 17; gill rakers 21 to 27, usually 25. Scales above lateral line larger than those below. Body silvery-white with numerous blue and yellow stripes on head and body. Pectoral fins chalky; other fins gray. Black blotch often present beneath free margin of preopercle. Juveniles without lateral stripe. Caudal spot round, posterior to caudal base.

Description. — A moderate-sized species, mature adults average over 200 mm in standard length. General body form and pattern are shown in Fig. 5a. The posterior margin of the upper jaw reaches a point below the front of the eye. The preopercle is slightly serrated in adult specimens.

There are twelve spines in the dorsal fin and the anal fin includes three. Fin-ray counts are provided in Table 7.

The longitudinal scale rows immediately below the lateral line are oblique. The scales above the lateral line are larger than those below. Scale counts are given in Tables 8 and 9. The gill rakers are short and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are graphed in Fig. 16.

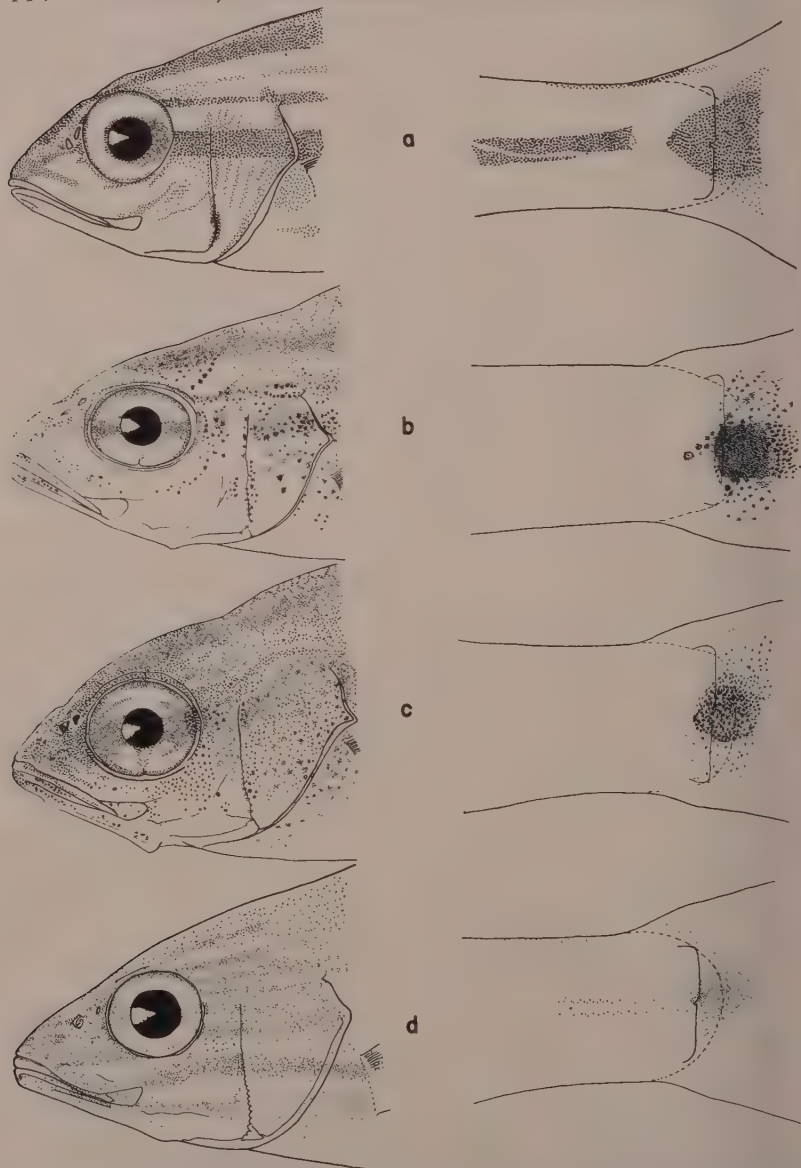


FIGURE 12. *Haemulon macrostomum*: a—UMML 3640, Florida Keys, 60.6 mm standard length. *H. plumieri*: b—UMML 2786, Florida Keys, 19.8 mm standard length. c—UMML 2786, 23.2 mm standard length. d—UMML 3639, Florida Keys, 35.6 mm standard length.

Coloration. — The typical color pattern of *plumieri* is shown in Fig. 5a. In life the body is silvery-white and the head is bronze to yellow above. The belly and underside of the head are white. A series of dark blue stripes, margined with bronze on the head, run back onto the body. The margin of each scale is bronze, the posterior edge often gray. In a darker phase the silvery-white in the center of each scale may become bronze.

The membranes of the spinous dorsal fin are chalky to yellowish-white. The soft dorsal, caudal, and soft anal fins are brownish-gray. The pelvic fins are chalky and the pectoral fins are light yellow to chalky.

There may be a black blotch beneath the free margin of the preopercle. The mouth is bright red within.

The peritoneum is black.

Juvenile pigmentation. — Juvenile specimens above 40 mm in standard length acquire the adult color pattern. The colors are lost to a great extent in preservation but the juvenile pattern is retained.

Juvenile pigmentation is shown in Figs. 12b-d and 13c. The lateral stripe is absent in young individuals of *plumieri*. The caudal spot is more or less round, its greatest volume posterior to the caudal base. The head and body are heavily covered with light melanophores. The larger scales above the lateral line are difficult to see in juvenile specimens.

Comparisons. — *H. plumieri* is related to *album*, *bonariense* and *macrostomum*. Adults of *plumieri* are distinguished by larger scales above the lateral line and the numerous dark blue stripes on the head. Young individuals are easily distinguished from other species by the absence of a lateral stripe.

Distribution and ecology. — The range of *plumieri* extends from Chesapeake Bay southward to Brazil and along the Central American coast into the Gulf of Mexico. During the summer months this species is abundant along the west coast of Florida as far north as Pensacola. During the cold winter of 1957 all species of *Haemulon*, with the exception of *plumieri* and *aurolineatum*, were found to be absent from the shallow inshore waters of Florida.

H. plumieri is the most abundant species of *Haemulon* in inshore Florida and Bahamian waters. It is found from the shore to the outer reef. The young are especially abundant on grass beds at the edge of sand flats.

Haemulon aurolineatum Cuvier

TOMTATE

Figs. 5b, 13b-d, 14a, Tables 1-10

- Haemulon chrysopterum* Cuvier, 1829: 176 (misidentification; in part; incorrectly includes *Perca chrysoptera* Linnaeus).—Günther, 1859: 313-314 (characters, synonymy; in part; West Indies, Jamaica, Trinidad, and Bahia).—Goode, 1880: 113 (Mayport, Fla.).
- Haemulon chrysopteron*, Cuvier, in Cuvier and Valenciennes, 1829: 240-241 (description; not of Linnaeus; in part; New York and Catesby's figure of *Perca marina gibbosa cinerea*=*H. album*).—Storer, 1846: 74 (compiled).—Gill, 1862: 32 (compiled).—Holbrook, 1875: 120-123, Pl. 17, Fig. 1 (characters, range; South Carolina).—Uhler and Lugger, 1876: 105-106 (compiled; lower Chesapeake Bay, unconfirmed record by authors).
- Haemulon aurolineatum* Cuvier, in Cuvier and Valenciennes, 1829: 237-238 (original description; type localities: Brazil, San Domingo).—Storer, 1846: 75 (description of young).—Castelnau, 1855: 11 (Bahia).—Günther, 1859: 316-317 (characters).—Bean, 1883: 58 (Pensacola; range).—Jordan, 1884a: 126 (synonymy; Key West); 1884c: 78 (name only).—Jordan and Swain, 1884b: 310-311 (compiled).—Jordan, 1886: 42 (Havana); 1887a: 877 (name only); 1887c: 584 (compiled).—Jordan and Fesler, 1893: 478 (compiled).—Lönnerberg, 1895: 658 (Cape Haitien, Haiti).
- Hemulon chrysopteron*, DeKay, 1842: 85-86, Pl. 7, Fig. 22 (emended spelling; misidentification; in part; figure good).
- Haemulon jeniguano* Poey, 1860: 183-184 (first complete description of this species; Cuba); 1861a: 369 (name only); 1868: 319 (brief color description); 1875: 121 (name only).—Diaz, 1893: 93-94 (brief color description).—Howell-Rivero, 1938: 200 (synonymy).
- Bathystoma jeniguano*, Scudder, 1863: 12 (emended spelling; name only).
- Bathystoma chrysopterum*, Scudder, 1863: 13 (synonymy).
- Haemulum aurolineatum*, Cope, 1871: 471 (emended spelling; St. Martins).
- Diabasis aurolineatus*, Goode and Bean, 1883: 238 (Gulf of Mexico).—Jordan and Gilbert, 1883a: 276-277 (compiled; Pensacola); 1883b: 602-603 (compiled).—Goode, 1884: 398 (name; range); 1888: 80 (range; color notes).
- Diabasis chrysopterus*, Bean, 1883: 57 (Key West; range).—Jordan and Gilbert, 1883c: 553 (compiled).
- Diabasis jeniguano*, Bean, 1843: 58 (Garden Key, Tortugas; range).—Goode and Bean, 1833: 238 (name only).
- Haemulon rimator* Jordan and Swain, 1884b: 308-310 (description; Key West; Pensacola; incorrectly synonymized with *Perca striata* Linnaeus, *H. caudimacula* Poey).—Bean and Dresel, 1884: 158 (synonymy; Jamaica).—Jordan, 1887a: 877 (name only); 1887c: 584 (compiled).—Jordan and Bollman, 1889: 551 (Green Turtle Cay, Bahamas).—Adams and Kendall, 1891: 292, 309 (25°01'N to 25°02'49"N, north of Tortugas).—Henshall, 1891: 388 (Key West; Florida Keys).—Jordan and Fesler, 1893: 477-478, Pl. 41 (compiled; excel-

lent figure).—Henshall, 1895: 217 (Key West).—Smith, 1896: 176 (Biscayne Bay; observed).—Jordan and Evermann, 1896: 385 (compiled).—Brice, 1898: 282 (name only).—Jordan and Evermann, 1898: 1308-1309; 1900: Pl. 206, Fig. 534 (compiled; excellent figure).—Evermann and Kendall, 1900: 78 (compiled).—Evermann and Marsh, 1900: 192-193, Fig. 55 (compiled; Puerto Rico).—Barbour, 1905: 123 ((Flatts Inlet, Harrington Sound, Bermuda).—Bean, 1905: 307 (Clarence Harbor, Bahamas).—Jordan and Thompson, 1905: 242 (Tortugas).—Bean, 1906: 58 (compiled).—Fowler, 1906: 99 (Grassy Key, Hailer's Rocks, Marquesas, Fla.).—Smith, 1907: 293-294, Fig. 131 (compiled; figure good).—Jordan and Dickerson, 1908: 15 (Vera Cruz).—Blosser, 1909: 298 (St. Croix, Virgin Islands).—Nichols, 1912: 188 (Havana).—Fowler, 1915a: 256 (St. Thomas, Virgin Islands).—1915c: 535, 545 (St. Lucia).—Nichols, 1915: 143 (Ponce, Puerto Rico).—Ribeiro, 1915: 381-382 (compiled).—Jordan and Evermann, 1916: 428, photograph facing p. 434 (compiled; photograph good).—Ribeiro, 1918: 107-108 (compiled).—Fowler, 1919: 147, 153 (Kingston, Jamaica; Key West).—Longley, 1922: 172 (ecological note).—Breder, 1925: 154 (Caledonia Bay, Panama).—Meek and Hildebrand, 1925: 523-524 (compiled; Atlantic coast of Panama).—Breder, 1927: 46 (Alligator Reef, Fla.; Double-Headed Shot Cay, Bahamas).—Beebe and Tee-Van, 1928: 155-156, Fig. on p. 155 (compiled).—Borodin, 1928: 20 (Costa Rica; Cuba).—Fowler, 1928: 460 (Port-Au-Prince market, Haiti).—Hildebrand and Schroeder, 1928: 260-261 (Chesapeake Bay; compiled).—Nichols, 1929: 275, Fig. 147 (compiled; figure good).—Fowler, 1929: 640 (compiled).—Jordan, Evermann and Clark, 1930: 331 (compiled).—Fowler, 1937: 311 (Haiti); 1941: 161 (compiled).—Galloway, 1941: 119 (Key West; may be misidentified).—Longley and Hildebrand, 1941: 127-128 (Tortugas; observed; feeding habits; color description of young; range compiled).—Fowler, 1942a: 75 (observed in Cuban collection); 1942b: 11 (Bonacca Island, Bay Island group, Honduras); 1944: 446, 467 (compiled); 1945: 306-307 (Lemon Bay, Englewood, Sarasota County, Fla.; Plantation Key, Fla.; Light House Cove, near Palm Beach, Fla.).—Breder, 1948b: 176, Fig. on p. 176 (compiled; illustration fair).—Schultz, 1949: 134 (compiled).—Baughman, 1950: 250 (Heald Bank off Galveston, Texas).—Fowler, 1952: 96 (Port-Au-Prince, Haiti).—Gunter, 1952: 39 (Gulf of Campeche).

Bathystoma aurolineatum, Jordan and Evermann, 1896: 385 (compiled).—Jordan and Rutter, 1898: 110 (Kingston).—Jordan and Evermann, 1898: 1310; 1900: Pl. 207, Fig. 535 (compiled; figure fair).—Evermann and Kendall, 1900: 78 (compiled).—Bean, 1905: 307 (Abaco, Bahamas).—Jordan and Thompson, 1905: 242 (compiled).—Bean, 1906: 58 (Bermuda).—Nichols, 1915: 143 (Ponce market, Puerto Rico).—Ribeiro, 1915: 382 (compiled; not recorded from Brazil).—Jordan and Evermann, 1916: 428-429 (compiled).—Fowler, 1917b: 23 (Virgin Islands).—Ribeiro, 1918: 108 (synonymy; compiled).—Fowler, 1919: 137 (compiled).—Nichols, 1929: 275-276 (compiled; Ponce, Puerto Rico).—Fowler, 1929: 640 (compiled).—Longley, 1931: 386 (Tortugas; observed).—Beebe and Tee-Van, 1933a: 147-148 (compiled); 1933b: 151, Fig. on p. 151 (com-

piled; figure not correct).—Fowler, 1941: 162 (compiled).—Longley and Hildebrand, 1941: 127 (off Tortugas; range compiled).—Fowler, 1944: 446, 467 (compiled); 1945: 307 (compiled; Key West).—Breder, 1948b: 176 (compiled).—Fowler, 1952: 96 (compiled).—Erdman, 1956: 320 (spawning records; Puerto Rico).

Haemulon (Bathystoma) aurolineatum, Metzelaar, 1919: 81-82 (compiled; St. Martin).

Bathystoma aurolineatum aurolineatum Ginsburg, 1948: 153-155, Tables 1-3 (description; based on Hispaniola and American tropical Atlantic populations recognized as subspecifically distinct; Haiti; Dominican Republic; American tropical Atlantic).

Bathystoma aurolineatum rimator Ginsburg, 1948: 151-155, Tables 1-3 (description; based on United States populations recognized as subspecifically distinct; eastern United States coastline and Florida Keys; Tortugas).—Buller, 1951: 15 (off North and South Carolina and Virginia).—Hildebrand, 1954: 307, 347, Table 29 (compiled; Padre Island, Texas).—Reid, 1954: 41, 77, Table 7 (Cedar Key, Fla.).—Hildebrand, 1955: 209 (Gulf of Campeche).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 86 (compiled).—Springer and Woodburn, 1960: 41 (Egmont Key, Fla.; Anclote Key, Pasco County, Fla.).

Bathystoma aurolineatum angustum Ginsburg, 1948: 155, Tables 1-3 (description based on Bermuda population recognized as subspecifically distinct; Bermuda).

Material examined.—Florida: UMML 2868 (1, 106.4); UMML 1573 (1, 119.6); UMML 3288 (2, 69.9-77.0); UMML 3812 (2, 76.8-85.6); UMML 5024 (6, 138.4-185.1); UMML 885 (4, 135.7-148.6); UMML 5921 (2, 20.9-27.4); UMML 3642 (1, 53.9); UMML 5739 (1, 18.5); USNM 35190 (4, 52.8-79.6, paratypes of *H. rimator* Jordan and Swain); UMML 1084 (1, 111.4).

Gulf of Mexico: UMML 4215 (2, 136.2-140.4); UMML 4264 (6, 62.2-100.1).

Virgin Islands: UMML 5058 (1, 124.1).

Bermuda: USNM 20178 (1, 125.6, holotype of *Bathystoma aurolineatum angustum* Ginsburg); USNM 12708 (1, 103.5, paratype of *B. a. angustum*); USNM 144166 (3, 77.4-120.8, paratypes of *B. a. angustum*).

Diagnosis. — Pored lateral line scales 50 to 52; caudal-peduncle scales 22 (9-2-11); dorsal fin 12+1, 14 to 15, usually 15; anal fin 3, 9, rarely 8; pectoral fins 17 to 18, usually 17; gill rakers 24 to 28. Longitudinal scale rows below lateral line parallel to long axis of body. Body silvery-white with yellow to brown stripe from behind preopercle to black blotch at base of caudal fin. Pectoral fins chalky; other fins pale gray to chalky. Juveniles with lateral stripe from behind eye to caudal peduncle continuous with oval spot when young, separate from dumbbell-shaped spot in larger individuals.

Description. — A moderate sized species, mature adults average between 125 and 175 mm in standard length. The largest specimen

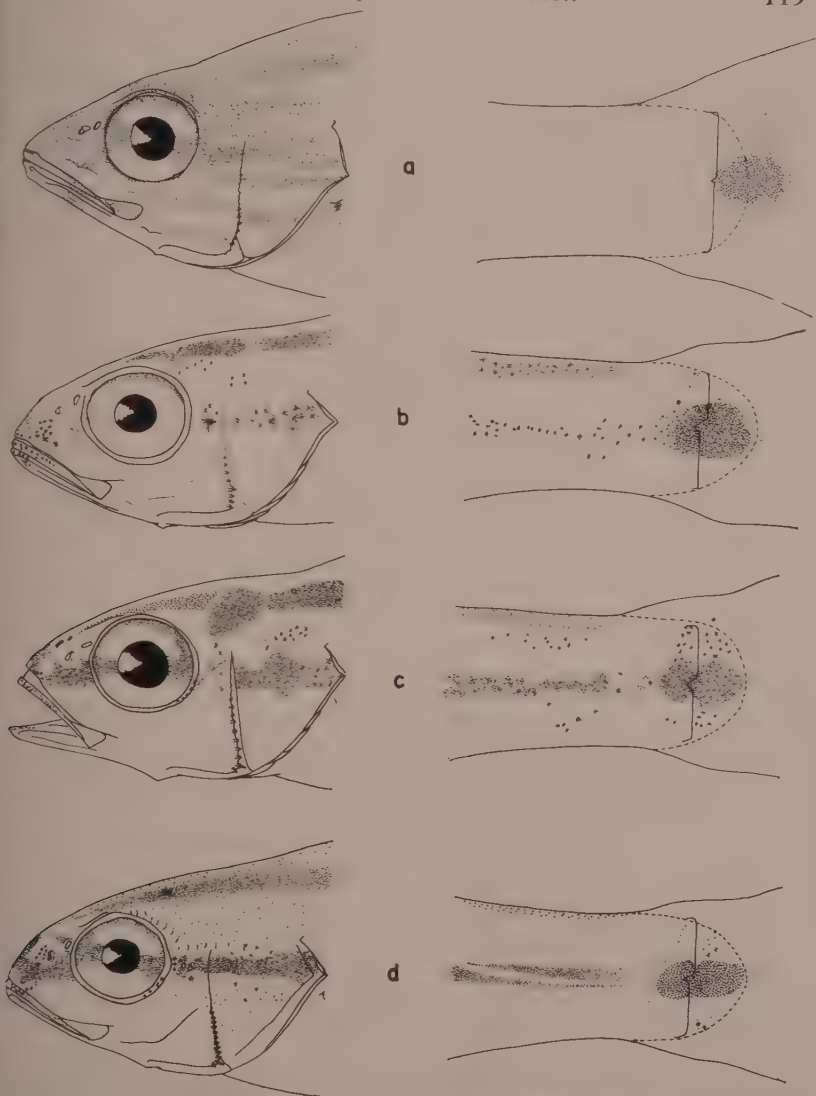


FIGURE 13. *Haemulon plumieri*: a—UMML 3639, Florida Keys, 42.5 mm standard length. *H. aurolineatum*: b—UMML 5739, Florida Keys, 18.5 mm standard length. c—UMML 5921, Florida Keys, 20.9 mm standard length. d—UMML 5921, 27.4 mm standard length.

examined was 185 mm in standard length. The general body form is shown in Fig. 5b. The posterior margin of the upper jaw reaches a point below the posterior edge of the lens of the eye. The preopercle is serrated in the adults.

The dorsal fin includes thirteen dorsal spines and the anal fin contains three. Fin-ray counts are given in Table 7.

The longitudinal rows of scales below the lateral line are parallel to the long axis of the body. Scale counts are given in Tables 8 and 9. The gill rakers are short and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are graphed in Fig. 16.

Coloration. — The typical color pattern of *aurolineatum* is shown in Fig. 5b. The body is silvery-white in life. The head is dusky gray-brown with a gray snout. A bronze to yellow lateral stripe runs the length of the body from behind the opercle to a large, dark brown or black caudal spot which is present in the adult. The dorsal, caudal, anal, and pelvic fins are chalky to light gray. The base of the soft dorsal and soft anal fins is dusky gray.

The black blotch beneath the free margin of the preopercle is absent in this species. The mouth is red within.

The peritoneum is black.

Juvenile pigmentation. — The juvenile pigmentation of *aurolineatum* is illustrated in Figs. 13b-d and 14a. The caudal spot is similar to that of *flavolineatum*. In young individuals the caudal spot and the lateral stripe are connected by scattered, dark melanophores. Later they become separated. As growth continues, the oval spot is slightly constricted over the caudal base. This becomes more pronounced until the caudal spot spreads onto the caudal fin and the adult pattern is reached.

Comparisons. — Adults of *aurolineatum* are easily distinguished from other species of *Haemulon* because they possess thirteen dorsal spines. *H. striatum* is very different. The body of *aurolineatum* is more laterally compressed than that of *striatum*. Caudal-peduncle scale counts and anal-ray counts will distinguish these forms.

Large juveniles of *aurolineatum* are sometimes confused with those of *sciurus* or *carbonarium*. The dorsal-spine count will separate these forms.

The young of *aurolineatum* closely resemble those of *flavolineatum*. These relationships are discussed with *flavolineatum*.

Distribution and ecology. — The range of *aurolineatum* extends from south of Cape Cod to Brazil and along the Central American coast throughout the Gulf of Mexico. Its Bermuda representatives are recognized as subspecifically distinct by Ginsburg (1948: 153-155). In the cold winter of 1957 this species and *plumieri* were the only forms of *Haemulon* which remained in shallow inshore waters off Florida.

H. aurolineatum occurs from the shore to the outer reef in Florida. It is found in abundance on the shrimp grounds of Tortugas and the Gulf of Mexico.

Remarks. — The subspecies of *aurolineatum* designated by Ginsburg (1948: 151-156) are not treated as such in this study.

Haemulon chrysargyreum Günther

SMALLMOUTH GRUNT

Figs. 5c, 14b-c, Tables 1-10

Haemulon chrysargyreum Günther, 1859: 314-316 (original description; type localities: West Indies and Trinidad); 1880: 7 (Fernando Noronha, off Brazil).—Jordan and Swain, 1884b: 307 (compiled).—Jordan, 1887b: 536 (notes on above specimens); 1887c: 584 (compiled).—Jordan and Fesler, 1893: 476-477, Pl. 40 (compiled).

Haemulon taeniatum Poey, 1860: 182-183 (description; Cuba); 1861a: 369 (compiled); 1868: 319 (compiled; color note).—Jordan, 1884a: 127 (Key West); 1884c: 78 (name only); 1886: 42 (Havana).—Jordan and Swain, 1884b: 307-308 (compiled).—Jordan, 1887a: 878 (name only).—Howell-Rivero, 1938: 199-200 (compiled).

Brachygenys taeniatum, Scudder, in Poey, 1875: 121-122 (type of *Brachygenys* Scudder).

Brachygenys chrysargyreus, Jordan and Rutter, 1898: 110 (Kingston, Jamaica).—Jordan and Evermann, 1896: 385 (compiled); 1898: 1307-1308; 1900: Pl. 206, Fig. 533 (characters, synonymy; compiled; figure fair).—Evermann and Kendall, 1900: 78 (compiled).—Bean, 1905: 308 (Abaco, Bahamas).—Jordan and Thompson, 1905: 242 (Tortugas).—Fowler, 1915c: 535 (compiled).—Ribeiro, 1915: 383-384 (characters, range; compiled).—Jordan and Evermann, 1916: 429 (name only).—Ribeiro, 1918: 108-109 (compiled).—Nichols, 1921: 23 (Turks Island, Bahamas).—Longley, 1922: 172 (feeding habits).—Breder, 1927: 47 (Eleuthera Island, Double-headed Shot Cay, Bahamas and Grand Cayman).—Beebe and Tee-Van, 1928: 157, Fig. on p. 157 (Port-Au-Prince Bay, Haiti).—Fowler, 1928: 470 (St. Lucia, British West Indies).—Gudger, 1929: 182 (compiled).—Fowler, 1929: 639 (Trinidad; Colon, Panama); 1930a: 273 (Grenada, British West Indies).—Jordan, Evermann and Clark, 1930: 331 (compiled).—Fowler, 1941: 161 (compiled).—Longley and Hildebrand, 1941: 128, Pl. 16, Fig. 1 (ecological notes; color description).—Fowler, 1944: 446, 467 (compiled).—Breder, 1948b: 177 (com-

piled).—Fowler, 1952: 96, Fig. 22 (compiled; figure poor); 1953: 63 (Seranilla Bank, off Colombia).—Erdman, 1956: 332 (occurrence in Puerto Rico and local common names).—Briggs, 1958: 279 (compiled).—Duarte-Bello, 1959: 86 (compiled).

Haemulon (Brachygenys) chrysargyreus, Metzelaar, 1919: 81 (compiled; Curacao; Bonaire; St. Martin).

Material examined.—Florida: UMML 285 (1, 81.2); UMML 1181 (3, 84.1-91.8); UMML 1079 (1, 137.5); UMML 3229 (3, 56.9-64.2); UMML 5201 (1, 67.9); UMML 2025 (5, 83.4-104.4); UMML 5166 (1, 46.4); CRR-F-193 (3, 92.1-95.5).

Western Bahamas: UMML 494 (2, 137.5-145.5); UMML 2840 (2, 41.8-44.3); UMML 5325 (1, 33.7).

Cuba: USNM 4703 (1, 139.4, paratype of *H. taeniatum* Poey).

Puerto Rico: UMML 1922 (1, 103.3).

Jamaica: C-4-2059-1J Morant (2, 51.2-53.5).

Diagnosis. — Pored lateral-line scales 49 to 51, usually 50; caudal peduncle scales 21 to 22, usually 22 (9-2-11); dorsal fin 11+1, 13; anal fin 3, 9 to 10, usually 9; pectoral fins 15 to 17, usually 16; gill rakers 30 to 33. Mouth small. Longitudinal scale rows below lateral line parallel to long axis of body. Body with yellow and bluish-gray stripes. All fins yellow except pectorals which are chalky. Juveniles with lateral stripe from behind eye to caudal peduncle, constricted and oblique at caudal base, terminating in amorphous caudal spot.

Description. — A moderate-sized species, mature adults average 150 to 175 mm in standard length. The general body form is shown in Fig. 5c. The posterior margin of the upper jaw reaches a point below the front of the eye. The preopercle is serrated in the adult.

The dorsal fin contains twelve spines and the anal fin includes three. Fin-ray counts are provided in Table 7.

The longitudinal scale rows below the lateral line are parallel to the long axis of the body. Scale counts are given in Tables 8 and 9. The gill rakers are short and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are shown in Fig. 16.

Coloration. — Fig. 5c shows the typical color pattern of *chrysargyreum*. In life the body is striped with yellow and bluish-gray. All fins are yellow except the pectorals which are chalky. The axil of the pectoral fin is steel gray. The mouth is red within.

The peritoneum is black.

Juvenile pigmentation. — Juvenile pigmentation of *chrysargyreum* is shown in Figs. 14b-c. The lateral stripe is continuous with a

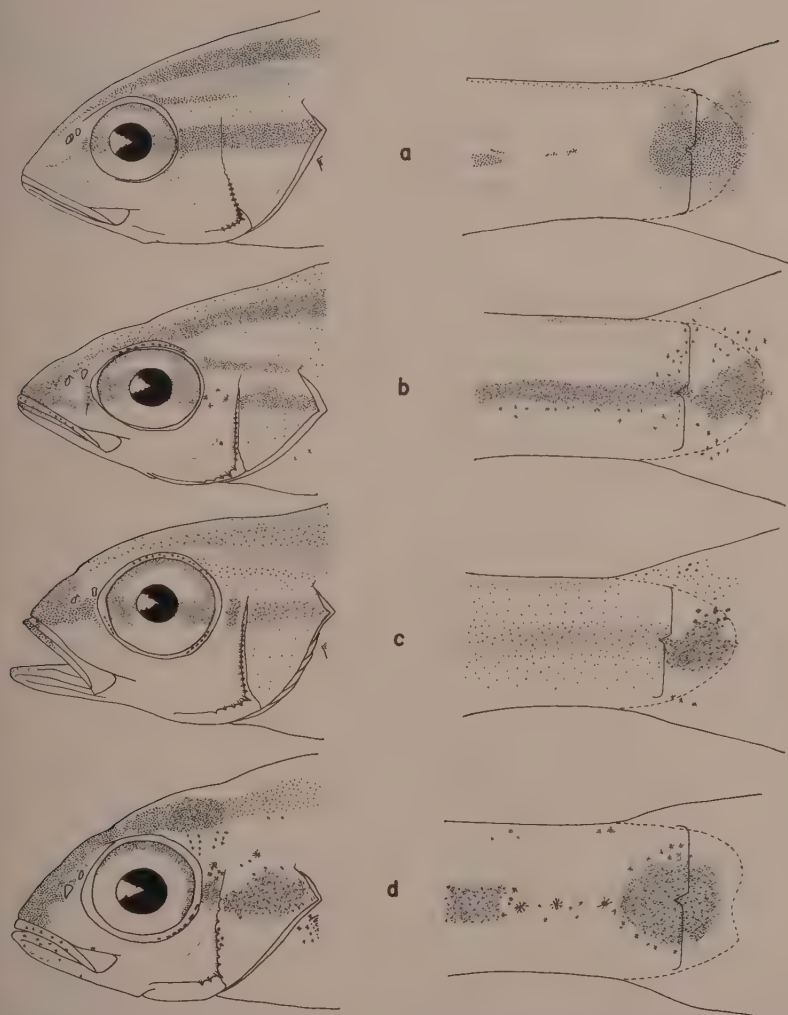


FIGURE 14. *Haemulon aurolineatum*: a—UMML 3642, Florida Keys, 53.9 mm standard length. *H. chrysargyreum*: b—UMML 5325, western Bahamas, 34.2 mm standard length. c—UMML 2840, western Bahamas, 42.2 mm standard length. *Anisotremus surinamensis*: d—UMML 5616, southern Florida, 19.6 mm standard length. The large caudal peduncle spot differs in shape, position and size than that characteristic of *Haemulon*.

peculiarly-shaped caudal spot. The spot is located posterior to the caudal base and is joined to the lateral stripe by an oblique, constricted band of melanophores. This pattern is retained until the transition to the adult form.

Comparisons. — *H. chrysargyreum* is quite distinct from the other species of *Haemulon* in life. It is closest to *striatum* but differs from the latter species by having twelve dorsal spines instead of thirteen and a lower caudal peduncle scale count. The color pattern is also a distinguishing character.

This species differs from the other species of *Haemulon* in having a smaller mouth, more elongate body, and fewer dorsal rays. Young individuals resemble those of *sciurus* and are distinguished by the shape of the caudal spot and the longitudinal scale rows which are parallel to the long axis of the body.

Distribution and ecology. — *H. chrysargyreum* occurs from the Miami area southward to Brazil and along the Central American coast to the southern Gulf of Mexico. It inhabits shallow waters from the shore to the reefs off Florida where it may be found in sizeable schools.

Haemulon striatum (Linnaeus)

Fig. 5d, Tables 1-10

Capeuna brasiliensis Marcgrave, 1648: 155 (brief, inadequate description; Brazil).

Perca striata Linnaeus, 1758: 293 (original description; type locality: America).—Gmelin, 1788: 1319 (compiled).—Walbaum, 1792: 348 (compiled).

Grammistes striatus, Bloch and Schneider, 1801: 182 (based on *P. striata* Linnaeus).

Grammistes trivittata Bloch and Schneider, 1801: 188 (based on *Capeuna brasiliensis* Marcgrave).—Cuvier, 1834: 156 (in part; incorrectly synonymized with *P. chrysoptera* Linnaeus and *H. chrysoptera* Cuvier).

Sparus striatus, Shaw, 1803: 441 (compiled).

Serranus capeuna Lichtenstein, 1821: 288 (based on *Capeuna* Marcgrave and *Grammistes trivittata* Bloch and Schneider).

Haemulon capeuna, Cuvier, 1829: 176 (compiled).

Haemulon quadrilineatum Cuvier, in Cuvier and Valenciennes, 1829: 238-240, Pl. 120 (description; San Domingo; figure in color, good).

—Guichenot, 1843: 180 (compiled).—Storer, 1846: 75 (compiled).

—Günther, 1859: 316 (compiled).—Poey, 1861a: 369 (name only);

1866: 310 (synonymy); 1868: 319 (compiled); 1875: 121 (compiled).

—Gill, 1873: 806 (compiled; range).—Jordan and Swain,

1884b: 311-313 (compiled).—Jordan, 1887c: 584 (compiled).—

Diaz, 1893: 93 (compiled).

Haemulon quinquelineatum Poey, 1861a: 369 (name only); 1861b: 419 (description; Cuba); 1868: 161 (synonymy).—Howell-Rivero,

1938: 200 (synonymy; compiled).

Haemulon quadrilineatum, Cope, 1871: 471 (St. Croix).

Haemulon capeuna, Goode, 1876: 53 (compiled; Bermuda); 1877a: 5 (compiled); 1877b: 292 (compiled).

Diabasis trivittatus, Jordan and Gilbert, 1883c: 554 (synonymy).—Diaz, 1893: 93 (name only).

Haemulon striatum, Jordan and Fesler, 1893: 479 (compiled).

Haemulon trivittatum, Lönnberg, 1894: 128 (Key West).

Bathystoma striatum, Jordan and Evermann, 1896: 385 (compiled); 1898: 1310-1311 (compiled).—Evermann and Kendall, 1900: 78 (compiled).—Evermann and Marsh, 1900: 193 (compiled).—Barbour, 1905: 123 (Flatts Inlet, Bermuda).—Jordan and Thompson, 1905: 242 (color description; Tortugas).—Bean, 1906: 58 (compiled).—Nichols, 1912: 188 (Marianao, Cuba; observed).—Fowler, 1915c: 536 (Trinidad).—Ribeiro, 1915: 382-383 (compiled).—Jordan and Evermann, 1916: 429 (compiled).—Fowler, 1917b: 23 (Virgin Islands).—Ribeiro, 1918: 108 (compiled).—Fowler, 1919: 144 (compiled).—Nichols, 1921: 23 (Turk Island).—Meek and Hildebrand, 1925: 524-525 (compiled; not recorded from Panama).—Breder, 1927: 46-47 (questionable identification; Double-headed Shot Cay, Bahamas).—Beebe and Tee-Van, 1928: 156, figure (Port-Au-Prince, Haiti; figure fair).—Borodin, 1928: 20 (Cuba).—Nichols, 1929: 276, Fig. 148 (compiled).—Fowler, 1929: 640 (compiled).—Jordan, Evermann and Clark, 1930: 331 (compiled).—Beebe and Tee-Van, 1933b: 151-152, figure (compiled; figure not *striatum* but *H. aurolineatum*).—Fowler, 1941: 162 (compiled).—Galloway, 1941: 119 (questionable identification; Key West).—Longley and Hildebrand, 1941: 128 (notes on body form; range).—Fowler, 1944: 446 (compiled).—Breder, 1948b: 176 (compiled).—Ginsburg, 1948: 155-156, Tables 1-3 (characters, color pattern).—Fowler, 1952: 96, Fig. 23 (Port-Au-Prince).—Hildebrand, 1955: 210 (Gulf of Campeche, Lobos Island fishing grounds).—Duarte-Bello, 1959: 86 (compiled).

Haemulon (Bathystoma) striatum, Metzelaar, 1919: 82 (compiled; West Indies).

Material examined.—Gulf of Mexico: M/V SILVER BAY, sta. 11 (2, 133.8-143.5).

Cuba: USNM 4702 (1, 138.1, holotype of *H. quinquelineatum* Poey); USNM 9839 (1, 150.6); USNM 7438 (2, 98.8-129.1).

Haiti: USNM 178330 (1, 173.7); USNM 133700 (1, 140.7).

Venezuela: R/V ATLANTIS (3, 112.7-139.5).

Surinam: UMML 5530 (20, 46.5-87.3).

Diagnosis. — Pored lateral-line scales 51 to 53, rarely higher; caudal-peduncle scales 25 to 27, usually 26; dorsal fin 12+1, 13 to 14, rarely 12; anal fin 3, 7 to 9, usually 8; pectoral fins 17 to 19, usually 18; gill rakers 28 to 34, usually 32. Mouth small. Body not strongly compressed. Preserved specimens silvery-white with four or five brown stripes. Dorsal, caudal, and soft anal fins light to dark gray. Pelvic and pectoral fins chalky.

Description. — A moderate-sized species, adults average 150 to 175 mm in standard length. The general body form and pattern are shown in Fig. 5d. The body is not as laterally compressed as in the other species of *Haemulon*. The mouth is small, the posterior margin of the upper jaw reaching to a point below the anterior third of the lens of the eye. The preopercle is serrated in the adult.

The dorsal fin includes thirteen spines and the anal fin contains three. Fin-ray counts are provided in Table 7.

The longitudinal scale rows below the lateral line are oblique. Scale counts are given in Tables 8 and 9. The gill rakers are moderately long and total counts are shown in Table 10.

Morphometric data are provided in Tables 1 to 6 and eye length-standard length relationships are graphed in Fig. 16.

Coloration. — The typical adult color pattern is shown in Fig. 5d. In life the body is grayish white above and silvery-white on the belly. The lateral stripes are black superimposed on yellow. The snout is greenish yellow. Each scale above the lateral line is margined with dark gray. The caudal peduncle is gold with white near the mid-ventral line. The dorsal-fin membranes are colorless. The anal, pelvic and pectoral fins are chalky. Both the soft dorsal and caudal fins are reddish-orange. Younger specimens lack these stripes except for a lateral stripe from behind the eye to a rectangular-shaped caudal spot.

Juvenile pigmentation. — No juveniles less than 46.5 mm in standard length were seen during this study. Specimens of this size are easily recognized by the adult characters.

Comparisons. — This species is characterized by the presence of thirteen dorsal spines. *H. aurolineatum* also has the same number of dorsal spines but these two species are quite different. The longitudinal scale rows below the lateral line of *aurolineatum* are parallel to the long axis of the body. Those of *striatum* are oblique. Caudal peduncle scale counts of *striatum* are much higher than those of *aurolineatum*. The body of *aurolineatum* is more laterally compressed than that of *striatum*. A great difference exists in mouth size as is shown in Figs. 5b and d.

H. striatum is more closely related to *chrysargyreum* than to any other species of *Haemulon*. These relationships are discussed with the latter species.

Distribution and ecology. — This species occurs from the Gulf of

Mexico through the West Indies to Brazil and along the Central American coast.

Little is known of the ecology of this species. Most specimens were taken by trawling operations which indicates a preference for moderately deep water.

Haemulon schranki Agassiz

Haemulon schrankii Agassiz, 1829: 131, Pl. 69a (description; Atlantic; Brazil).—Günther, 1859: 310-311 (compiled).—Poey, 1868: 314 (comparison with *H. album*; inconclusive).—Jordan, 1885a: 547 (additional characters from type specimens).—Jordan, Evermann and Clark, 1930: 330 (synonymized under *H. melanurum*).

Haemulon schranki Jordan, 1890: 648 (emended spelling; Port Castries, St. Lucia; synonymized with *H. steindachneri*).—Jordan and Fesler, 1893: 473 (range; synonymized with *H. steindachneri*; synonymy confused).—Jordan and Evermann, 1898: 1303 (synonymized under *H. melanurum*).

The description and figure in Agassiz (1829: 131, Pl. 69a) are unsatisfactory. The additional characters reported by Jordan (1885a: 547) are incomplete. In 1890 and with Fesler in 1893, Jordan synonymized this species with *steindachneri*. In later works (1898: 1303, with Evermann, and 1930: 330, with Evermann and Clark) he allied *H. schranki* with *melanurum*. As Agassiz's figure and diagnosis do not agree with those of *melanurum*, the identification of *schranki* with *melanurum* is probably wrong. Possibly, *schranki* is *steindachneri* of the Atlantic in which case *schranki* would replace the latter name. On the basis of available data *schranki* may not be identified with any known species of *Haemulon*. Only an examination of the type material can solve this problem.

SUMMARY

The variation, juvenile pigmentation, relationships, and distribution of western Atlantic fishes of the genus *Haemulon* are treated. The nominal genera of *Bathystoma* and *Brachygenys* are considered synonymous with *Haemulon*. Thirteen species are recognized.

Morphology and pigmentation of juvenile forms indicate closer relationships between the species of *Haemulon* than is suggested by adult individuals. This is clearly illustrated when one compares young specimens of *aurolineatum* and *flavolineatum* or *sciurus* and *melanurum*. Such examples are repeated throughout the group.

The majority of the species are distributed from Florida through

the West Indies to Brazil and along the Central American coast to the southern Gulf of Mexico. *H. aurolineatum* and *plumieri* occur throughout this region and enter temperate waters along the eastern shores of the United States.

Haemulon steindachneri Jordan and Gilbert occurs on both coasts of Central America and the divided populations are not differentiated. The Atlantic distribution of this species from Panama to Brazil indicates: (1) a recent entrance of this form from the Pacific, or (2) a lower Caribbean origin with ecological factors restricting northward distribution.

Haemulon schranki Agassiz may not be identified with any known species of the genus at the present time.

APPENDIX

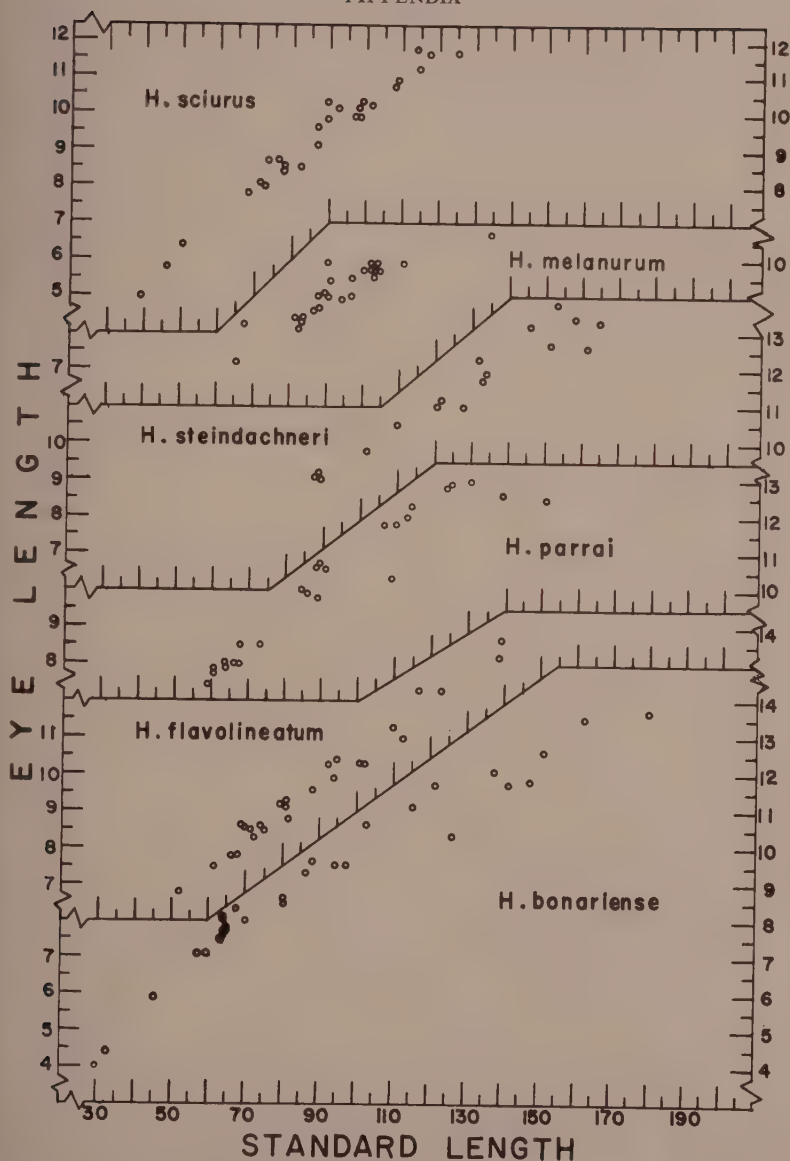


FIGURE 15. Eye length-standard length relationship of six species of *Haemulon*. (Scale in mm)

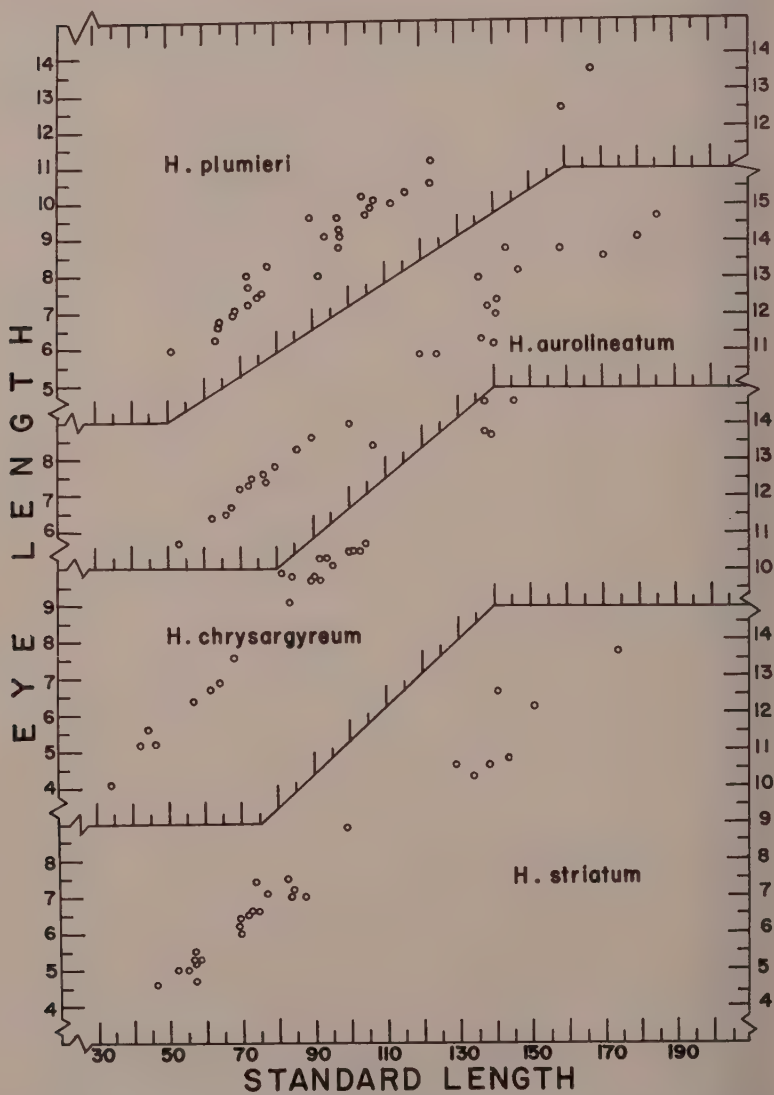


FIGURE 16. Eye length-standard length relationship of four species of *Haemulon*. (Scale in mm)

TABLE 2

FREQUENCY DISTRIBUTION OF THE PREANAL DISTANCE IN *Haemulon*
IN PER CENT STANDARD LENGTH.

	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
<i>H. sciurus</i>	—	—	—	—	—	—	1	4	5	8	7	1	—	1	—
<i>H. melanurum</i>	—	—	—	—	—	2	6	2	8	6	1	—	—	—	—
<i>H. steindachneri</i>	—	—	—	—	—	—	—	1	5	4	3	4	—	—	—
<i>H. parrai</i>	—	—	—	—	1	—	3	3	8	2	5	3	—	—	—
<i>H. flavolineatum</i>	—	1	—	—	—	2	6	7	6	3	2	1	—	—	—
<i>H. carbonarium</i>	—	—	—	—	1	1	8	7	5	3	1	—	—	—	—
<i>H. album</i>	—	—	—	—	—	—	5	1	4	1	—	—	—	—	—
<i>H. bonariense</i>	—	—	—	—	—	—	—	1	1	2	9	6	3	2	1
<i>H. macrostomum</i>	—	—	—	—	—	2	—	2	2	5	8	4	1	—	—
<i>H. plumieri</i>	—	—	—	—	—	—	1	4	6	5	8	4	—	—	—
<i>H. aurolineatum</i>	—	—	—	1	—	8	9	8	6	1	1	—	—	—	—
<i>H. chrysargyreum</i>	3	—	3	5	3	2	—	—	—	—	—	—	—	—	—
<i>H. striatum</i>	—	—	4	2	11	9	1	—	1	—	—	—	—	—	—

TABLE 3

FREQUENCY DISTRIBUTION OF BODY DEPTH IN *Haemulon* IN PER CENT
STANDARD LENGTH.

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
<i>H. sciurus</i>	—	—	—	—	—	—	—	—	—	—	5	8	13	1	—	—	—
<i>H. melanurum</i>	—	—	—	—	—	—	—	1	4	13	3	3	—	—	—	—	—
<i>H. steindachneri</i>	—	—	—	—	—	—	—	—	2	4	7	2	2	—	—	—	—
<i>H. parrai</i>	—	—	—	—	—	—	—	—	—	—	2	2	6	14	1	—	—
<i>H. flavolineatum</i>	—	—	—	—	—	—	1	2	7	11	5	2	—	—	—	—	—
<i>H. carbonarium</i>	—	—	—	—	—	—	—	—	1	—	5	10	6	3	1	—	—
<i>H. album</i>	—	—	—	—	—	—	—	—	—	—	—	1	2	2	4	—	2
<i>H. bonariense</i>	—	—	—	—	—	—	—	2	1	3	5	3	4	3	3	1	—
<i>H. macrostomum</i>	—	—	—	—	—	—	—	—	—	—	1	2	4	5	5	5	2
<i>H. plumieri</i>	—	—	—	—	—	—	—	—	—	—	—	4	12	10	1	—	1
<i>H. aurolineatum</i>	—	2	1	1	1	2	4	6	7	5	3	1	1	—	—	—	—
<i>H. chrysargyreum</i>	—	1	2	3	5	2	7	4	—	1	—	—	—	—	—	—	—
<i>H. striatum</i>	2	7	6	6	5	1	1	—	—	—	—	—	—	—	—	—	—

TABLE 4

FREQUENCY DISTRIBUTION OF HEAD LENGTH IN *Haemulon* IN PER CENT
STANDARD LENGTH.

	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
<i>H. sciurus</i>	—	—	—	—	—	—	—	—	—	2	2	12	9	2	—
<i>H. melanurum</i>	—	—	—	—	—	—	—	1	4	8	9	3	—	—	—
<i>H. steindachneri</i>	—	—	—	—	—	—	1	6	4	3	1	1	—	—	—
<i>H. parrai</i>	—	—	—	—	—	—	—	1	2	5	8	8	—	1	—
<i>H. flavolineatum</i>	—	—	—	—	—	—	—	1	10	7	8	2	—	—	—

FREQUENCY DISTRIBUTION OF LENGTH OF UPPER JAW IN *Haemulon*
IN PER CENT STANDARD LENGTH.

TABLE 7
FREQUENCY DISTRIBUTION OF FIN-RAY COUNTS IN *Haemulon*.

	DORSAL RAYS									ANAL RAYS					PECTORAL RAYS					
	12	13	14	15	16	17	18	19		5	6	7	8	9	10	15	16	17	18	19
<i>H. sciurus</i>	—	—	—	1	28	8	—	—		—	—	—	1	36	2	1	34	7	—	—
<i>H. melanurum</i>	—	—	—	9	30	2	—	—		—	—	1	39	1	—	—	5	33	4	—
<i>H. steindachneri</i>	—	—	—	2	13	2	—	—		—	—	—	2	15	—	—	—	6	10	1
<i>H. parrai</i>	—	—	—	—	2	12	11	1		—	—	—	25	1	—	—	1	29	—	—
<i>H. flavolineatum</i>	—	—	15	23	—	—	—	—		—	—	1	37	—	—	—	35	3	—	—
<i>H. carbonarium</i>	—	—	—	22	4	—	—	—		—	—	1	24	1	—	—	3	23	—	—
<i>H. album</i>	—	—	—	—	9	2	—	—		1	—	1	9	—	—	—	—	—	7	4
<i>H. bonariense</i>	—	—	—	12	14	1	—	—		—	—	—	24	3	—	—	5	22	—	—
<i>H. macrostomum</i>	—	—	—	4	19	2	—	—		—	—	—	1	24	—	—	—	2	23	—
<i>H. plumieri</i>	—	—	—	5	32	4	—	—		—	—	—	6	35	—	—	1	40	—	—
<i>H. aurolineatum</i>	—	—	7	26	1	—	—	—		—	—	1	1	32	—	—	1	26	7	—
<i>H. chrysargyreum</i>	1	23	1	—	—	—	—	—		—	—	—	—	21	4	2	18	5	—	—
<i>H. striatum</i>	2	11	17	1	—	—	—	—		—	—	4	27	1	—	—	—	4	19	8

TABLE 8
FREQUENCY DISTRIBUTION OF SCALE COUNTS IN *Haemulon*.

	SCALES BELOW LATERAL LINE							SCALES ABOVE LATERAL LINE							SCALES AROUND CAUDAL PEDUNCLE						
	5	6	7	8	9	8	9	10	11	12	13	14	19	20	21	22	23	24	25	26	27
<i>H. sciurus</i>	—	—	1	38	—	—	—	—	—	39	—	—	—	—	—	39	—	—	—	—	—
<i>H. melanurum</i>	—	46	—	—	—	—	—	—	—	46	—	—	—	—	—	1	15	5	4	—	—
<i>H. steindachneri</i>	—	1	15	—	—	—	—	—	—	1	2	13	—	—	—	—	—	1	5	11	—
<i>H. parrai</i>	—	30	—	—	—	—	—	—	—	30	—	—	—	—	—	3	34	—	—	—	—
<i>H. flavolineatum</i>	—	38	—	—	—	—	37	1	—	—	—	—	—	—	—	—	38	—	—	—	—
<i>H. carbonarium</i>	—	25	—	—	—	—	—	—	—	25	—	—	—	—	—	—	30	—	—	—	—
<i>H. album</i>	—	—	11	—	—	—	—	—	—	—	—	11	—	—	—	—	—	—	4	7	1
<i>H. bonariense</i>	—	27	—	—	—	—	—	1	19	7	—	—	1	—	5	21	—	—	—	—	—
<i>H. macrostomum</i>	—	—	30	—	—	—	—	—	—	1	29	—	—	—	—	1	29	—	—	—	—
<i>H. plumieri</i>	41	—	—	—	—	—	—	—	41	—	—	—	—	—	—	—	40	1	—	—	—
<i>H. aurolineatum</i>	—	34	—	—	—	—	—	—	—	2	29	3	—	—	—	—	34	—	—	—	—
<i>H. chrysargyreum</i>	—	—	25	—	—	—	—	—	—	10	15	—	—	—	1	4	20	—	—	—	—
<i>H. striatum</i>	—	1	27	—	—	—	—	—	—	—	4	22	2	—	—	—	—	—	1	4	21

TABLE 9
FREQUENCY DISTRIBUTION OF TOTAL GILL-RAKER COUNTS IN *Haemulon*.

	LATERAL-LINE SCALES															
	44	45	46	47	48	49	50	51	52	53	54	55	56			
<i>H. sciurus</i>	—	—	—	—	13	12	10	4	—	—	—	—	—	—	—	—
<i>H. melanurum</i>	—	—	—	—	—	7	19	14	—	—	—	—	—	—	—	—
<i>H. steindachneri</i>	—	—	—	—	—	—	1	3	11	1	—	—	—	—	—	—
<i>H. parrai</i>	—	—	—	2	14	8	1	—	—	—	—	—	—	—	—	—
<i>H. flavolineatum</i>	—	—	—	3	10	22	3	—	—	—	—	—	—	—	—	—
<i>H. carbonarium</i>	—	—	—	—	—	16	10	1	—	—	—	—	—	—	—	—
<i>H. album</i>	—	—	—	—	—	1	3	5	2	—	—	—	—	—	—	—
<i>H. bonariense</i>	1	6	11	3	5	1	—	—	—	—	—	—	—	—	—	—
<i>H. macrostomum</i>	—	—	—	—	—	—	9	12	4	—	—	—	—	—	—	—
<i>H. plumieri</i>	—	—	—	—	3	7	17	14	—	—	—	—	—	—	—	—
<i>H. aurolineatum</i>	—	—	—	—	—	1	8	8	7	—	—	—	—	—	—	—
<i>H. chrysargyreum</i>	—	—	—	—	—	4	13	8	—	—	—	—	—	—	—	—
<i>H. striatum</i>	—	—	—	—	—	—	1	3	15	5	1	1	1	1	1	1

TABLE 10

FREQUENCY DISTRIBUTION OF TOTAL GILL-RAKER COUNTS IN *Haemulon*.

	GILL RAKERS																			
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
<i>H. sciurus</i>	—	—	—	—	—	—	—	—	—	1	2	7	17	9	2	—	—	—	—	—
<i>H. melanurum</i>	—	—	—	—	13	18	10	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>H. steindachneri</i>	—	—	—	—	—	4	3	6	4	—	—	—	—	—	—	—	—	—	—	—
<i>H. parrai</i>	—	—	—	—	—	3	7	13	3	—	—	—	—	—	—	—	—	—	—	—
<i>H. flavolineatum</i>	—	—	—	1	1	6	16	3	1	—	—	—	—	—	—	—	—	—	—	—
<i>H. carbonarium</i>	—	—	—	—	—	—	10	10	5	—	—	—	—	—	—	—	—	—	—	—
<i>H. album</i>	—	—	—	—	2	3	5	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>H. bonariense</i>	—	1	1	6	8	8	2	1	—	—	—	—	—	—	—	—	—	—	—	—
<i>H. macrostomum</i>	—	—	—	—	—	—	—	—	1	7	11	5	—	1	—	—	—	—	—	—
<i>H. plumieri</i>	—	—	—	—	2	—	4	3	12	6	3	1	—	—	—	—	—	—	—	—
<i>H. aurolineatum</i>	—	—	—	—	—	—	—	6	7	11	11	4	—	—	—	—	—	—	—	—
<i>H. chrysargyreum</i>	—	—	—	—	—	—	—	—	—	—	—	—	1	4	9	6	4	1	—	—
<i>H. striatum</i>	—	—	—	—	—	—	—	—	—	—	1	3	1	3	3	15	5	2	1	1

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YOUNG SCOMBROIDS FROM THE WATERS BETWEEN CAPE HATTERAS AND BAHAMA ISLANDS

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ABSTRACT

A collection of young scombroid fishes made by the United States Fish and Wildlife Service in 1953 and 1954 in the waters between Cape Hatteras and the Bahama Islands contained 50 specimens. These fish are either from stomachs of six species of pelagic fishes or from collections made with dip-nets. The following genera and species were represented: (1) *Thunnus atlanticus*, (2) *Katsuwonus pelamis*, (3) *Euthynnus alletteratus*, (4) *Auxis thazard*, (5) *Sarda sarda* (6) *Thunnus sp. indet.*, and (7) *Scomberomorus sp. indet.* It is inferred that the time of spawning of the various species of scombroids from that area conforms with the time of spawning in the southern portion of the Florida Current and in the Gulf of Mexico.

INTRODUCTION

Since 1952 the United States Fish and Wildlife Service has collected a considerable amount of biological, physical and chemical data in the Florida Current from Cape Hatteras to the area of Bahama Islands (Anderson *et al.*, 1956a and 1956b; Anderson and Gehringer, 1957a and 1957b, 1958a and 1958b, 1959a and 1959b, and 1959c). In the course of these activities numerous collections of young fishes resulted. Recently the author has had the opportunity to examine some of the scombroids from these collections. This paper summarizes the results.

I wish to thank Mr. William W. Anderson of the Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, for the loan of the young scombroids from collections of the South Atlantic Fishery Investigations. Permission to publish my findings was kindly granted by the Director, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service.

METHODS AND MATERIAL

The material originates from collections made by U. S. Fish and Wildlife Service personnel between May 1953 and December 1954 aboard M. V. *Theodore N. Gill*. The fish come either from stomachs of large pelagic fish caught on a troll or from collections made with a dip-net. The latter method consists of dipnetting small fish which ag-

gregate around sargasso weed or which at night are attracted by an electric light suspended over water from an anchored or drifting vessel. Table 1 lists the stations at which young scombroids were taken, together with details as to the place and method of capture.

The specimens, which had been preserved in formalin, were examined under a binocular microscope and were dissected or stained as necessary for identification.

The standard method for staining of bony parts has been employed, with alizarine red used for staining and potassium hydroxide and glycerol used for clearing (Clothier, 1950). Gill-raker counts, where possible, were made on the first arch, from the right side of the fish. Some of the material from the stomach contents was so far digested that these counts could not be made.

The measurement of total length represents the direct distance from the tip of the snout to the tip of the shortest median ray of the caudal fin.

For identification such criteria as general shape, pigmentation and meristic characters were used. For fish digested to a large extent the following characters proved to be most useful: (1) total number of vertebrae, (2) number of thoracic and caudal vertebrae, (3) position on the vertebral column of the vertebra with first closed haemal arch, and (4) gill-raker counts.

For convenience the nomenclature of Rivas (1951) has been followed, with the exception of employing *Thunnus albacares* in place of *T. argentivittatus* for the Atlantic yellowfin tuna.

RESULTS

Identified scombroids. There is present in this collection a total of fifty young scombroid specimens, including the following genera and species: *Thunnus atlanticus*, *Katsuwonus pelamis*, *Euthynnus alletteratus*, *Auxis thazard*, and *Sarda sarda*. In addition, a number of young forms were recognized as *Thunnus* and *Scomberomorus* but could not be assigned to species, as will be discussed later.

Blackfin tuna, *Thunnus atlanticus*

There are four blackfin tuna ranging in total length from 58 to 99 mm. All individuals originate from stomach contents (Table 1). These fish were caught in June and October.

The gill-raker counts for these fish are as follows:

Total length	Gill rakers
58 mm.	6+1+17
96 mm.	6+1+15; 7+1+16
99 mm.	6+1+16

TABLE 1
YOUNG SCOMBROID FISHES FROM M/V *Theodore N. Gill* COLLECTION

Cruise No.	Station No.	Date	Position N. lat. W. long.	Methods of capture	Thunnus atlanticus No. Length mm	Thunnus sp. No. Length mm	Katsuwonus pelamis No. Length mm	Euthynnus alietteratus No. Length mm	Axis thazard No. Length mm	Sarda sarda No. Length mm	Scomberomorus sp. No. Length mm	Unidentified No. Length mm
2	63	8 May, 1953	33°15'	76°23'		1 19						
2	71	9 May, 1953	34°04'	76°15'		6 14-22						
3		16 July, 1953	30°27'	79°01'	1 96				2 11,13			
4		11 Oct., 1953	26°05'	78°12'								1 15
4		11 Oct., 1953	26°01'	78°06'	1 96							
5	61	17 Feb., 1954	32°54'	77°03'						1 34		
7		12 June, 1954	27°44'	77°31'	1 99							
7		22 June, 1954	26°10'	78°13'	1 58							
7		26 June, 1954	30°20'	80°01'		1 15						
7		13 July, 1954	34°35'	75°15'				2 25,35				
8		29 Aug., 1954	26°39'	79°00'							1 20	
8		26 Sept., 1954	32°59'	78°16'		8 9-12					3 29-30	
8		26 Sept., 1954	32°58'	78°15'								
9		5 Dec., 1954	32°59'	76°40'			1 49					
9		5 Dec., 1954	32°50'	76°44'			3 50					
9		5 Dec., 1954	32°50'	76°44'			7 29-54					
9		5 Dec., 1954	32°59'	76°40'			9 25-69					

Thunnus sp. indet.

There are 16 individuals of *Thunnus* ranging in total length from 9 to 22 mm. These fish, with one exception, were caught with a dip-net. The captures took place in May, July and August. Gill-raker counts of a 15 mm long and a 22 mm long individual were, respectively, 0+1+13 and 3+1+18.

Five species of *Thunnus* could be expected in the region of capture. These are *T. thynnus*, *T. atlanticus*, *T. obesus*, *T. albacares*, and *T. alalunga*. Of these only juveniles of *T. thynnus* and *T. atlanticus* definitely occur in the waters of the Florida Current.

Specific identification of such small *Thunnus* sp., with present lack of knowledge of the developmental series of various *Thunnus* spp., cannot be attempted, as pointed out by Klawe and Shimada (1959).

Oceanic skipjack, *Katsuwonus pelamis*

This species is represented by 20 individuals ranging in total length from 25 mm to 69 mm. All specimens originate from stomach contents of four adult oceanic skipjack, which were captured on 5th December 1954, in the general area 33°00' N, 76°40' W (Figure 1). Some of the fish were digested to such an extent that it was impossible to establish the number of gill rakers for all twenty individuals. The following are the gill-raker counts which were made. It should be pointed out that, due to digestion, many of the total lengths could be only estimated.

Total length	Gill rakers	Total length	Gill rakers
25 mm	4+1+20	44 mm	7+1+31; 8+1+33; 9+1+35
29 mm	4+1+25	48 mm	7+1+33
35 mm	5+1+27	49 mm	8+1+31
38 mm	4+1+29	50 mm	8+1+35; 9+1+35; 9+1+36
42 mm	5+1+33	54 mm	9+1+33
		69 mm	10+1+36

From the foregoing, it appears that the full gill-raker complement is attained in *Katsuwonus pelamis* at a larger size than in closely related *Euthynnus alletteratus* or *Auxis thazard* (Klawe and Shimada, 1959).

Little tunny, *Euthynnus alletteratus*

Two individuals of *Euthynnus alletteratus*, 25 and 35 mm long, are in this collection. Both originate from the stomach of an adult of the same species which was captured in July (Table 1).

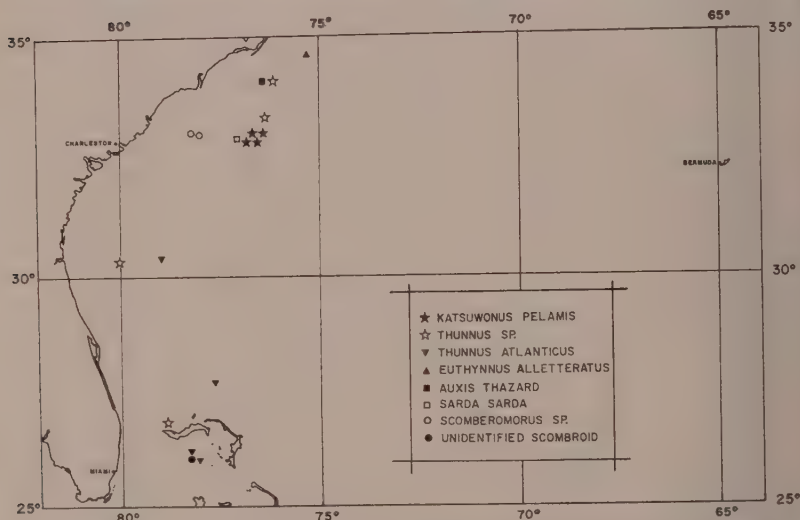


FIGURE 1. Localities of capture of young scombroids from M.V. *Theodore N. Gill* collection.

Frigate mackerel, *Auxis thazard*

Two small *Auxis thazard*, of total lengths 11 and 13 mm, were captured under a night light in May (Table 1) at Station 71, offshore between Charleston, S. C., and Cape Hatteras (Figure 1).

Bonito, *Sarda sarda*

A single 34 mm long individual of *Sarda sarda* was captured in February under a night light. The gill-raker count for this fish is 3+1+11.

Scomberomorus sp. *indet.*

Four fish of total lengths ranging from 20 to 30 mm are present in this collection. All originate from stomachs of two *Euthynnus* caught in September (Table 1).

These fish, although fairly well digested, are not beyond reliable generic identification. Specific identification could not be attempted, as the gill rakers could not be located on the first gill arch and the fish were decalcified to such an extent that no counts of fin rays could be made.

These juveniles could be young of any of the following three species: *S. cavalla*, *S. maculatus*, and *S. regalis*, all of which occur in the area of this investigation.

Spawning habits of scombroid fishes in the Florida Current

The importance of young tunas as indicators serving for delineation of areas and seasons of spawning has been discussed by Schaefer (1956), Klawe and Shimada (1959), and Klawe (1960). The last paper is especially applicable, since it deals with the southern portion of the Florida Current. In this case, however, we are dealing with an area where, on the whole, the surface currents are of considerable magnitude (Hela, 1954) and passive transportation of these young fish from some distant place into the area of capture is possible. Rivas (1954) and Klawe (1960) have shown that the southern portion of the Florida Current is a spawning area for some tunas. Whether the same applied to the rest of the Current is difficult to answer. Additional evidence is to be sought in collections of early larvae and eggs of various tunas from plankton tows made in the northern portion of the Florida Current. It is doubtful that the fish in the stomachs of predators could have been brought into the area of capture by ingestion and the subsequent migration of the predator. Although adult tuna and other large pelagic fishes are capable of moving considerable distances, the rate of digestion of rather soft and small items of food, such as young scombroids, is doubtless quite rapid.

Concerning the season of spawning of tunas here, it appears to be similar to that in the southern portion of the Florida Current inferred from studies of the larval material (Rivas, 1954; Klawe, 1960), i.e. spring, summer and fall.

From the capture of a single 34 mm *Sarda sarda* in February it appears that this species spawns in winter. This is not surprising, as off Dakar, on the eastern side of the Atlantic, Frade and Postel (1955) indicate that February and March are the times of spawning for that species. In the Gulf of Mexico juveniles of *S. sarda* have been collected in March (Klawe and Shimada, 1959).

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DISTRIBUTION AND SALINITY TOLERANCE IN
THE AMPHIURID BRITTLESTAR,
OPHIOPHRAGMUS FILOGRANEUS
(LYMAN, 1875)¹

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ABSTRACT

A brief discussion of the ecology and distribution of *Ophiophragmus filograneus* (Lyman) is given. This species is reported from salinities as low as 7.7‰, apparently a record low for echinoderms. Other examples of estuarine echinoderms are discussed.

The amphiurid brittlestar *Ophiophragmus filograneus* (Lyman, 1875) was originally described from the Cedar Keys region of the west coast of Florida. Since its description this species has been reported only once, when Pearson (1936) found it in Biscayne Bay near Miami. The writer has collected *O. filograneus* on the Florida east coast as far north as Melbourne where it occurs in the Indian River, and as far south as Whitewater Bay in the Everglades National Park. Other specimens were taken at Ft. Myers and Marco on the west coast and Lake Worth on the east coast. In all cases they were captured in the soft mud of bays separated from the ocean by land masses. Generally *O. filograneus* is associated with the marine monocotyledon *Diplanthera wrightii* (Ascherson) which has recently been treated by Phillips (1960). An apparently closely related ophiuroid, *Ophiophragmus wurdemani* Lyman occurs in fine quartz sand of shallow, more saline waters along Gulf of Mexico and Atlantic coast beaches.

While taking bottom samples from eastern Whitewater Bay during the summer of 1958 in connection with an ecological survey of Florida Bay estuaries financed by the State Board of Conservation, Marine Laboratory workers repeatedly captured many specimens of *O. filograneus* in areas of rather low salinity. The writer is indebted to his fellow workers, David L. Dubrow, Raymond B. Manning, and particularly Durbin C. Tabb for their aid in obtaining specimens and hydrographic data. Water samples were taken from the surface and a few inches off the bottom, read with a hydrometer, and corrected for temperature. The water in the areas sampled was five to eight feet deep and the bottom was soft gray mud with sparse *Diplanthera* growth.

¹Contribution No. 309 from The Marine Laboratory, University of Miami.

Specimens were obtained using both a small Peterson type grab and by scooping up bottom sediment with a dip-net. Associated with the brittlestar were the pelecypods *Anomalocardia cuneimeris* Conrad and *Macoma mitchelli* Dall, the gastropod *Melongena corona* Gmelin, a polychaete *Cistenides* sp., and a brachyuran crab *Rithropanopeus harrisii* (Gould).

At stations in Coot and Whitewater Bays where *O. filigraneus* was collected, bottom salinities of 7.7, 8.5, 8.7, 8.8, 9.4, 12.7, and 14‰ were recorded. Surface salinities were generally several parts per thousand lower than bottom salinities. Due to fresh water run-off from the everglades the influence of the tides is often slight in this estuary and periods of low salinity may last for weeks, particularly in eastern Whitewater Bay. *O. filigraneus* apparently tolerates these low salinities for extended periods of time. Since 1959, salinities have steadily decreased until now the water is almost fresh and no brittlestars appear to exist in the sample areas.

The phylum Echinodermata is well known as an exclusively marine assemblage. In the well studied Baltic area *Ophiura albida* Forbes and *Asterias rubens* Linnaeus may be found in salinities as low as ten parts per thousand, but do not exist east of the Belt Sea where salinities are lower (Brattstrom, 1941). Loosanoff (1945) found that *Asterias forbesi* (Desor) of the northwestern Atlantic is able to tolerate short salinity drops but dies when subjected to low salinities for more than a few days. In salinities of 7.5‰ all of his specimens died within 48 hours. At 12‰ all died within 106 hours, and at 14‰ all were dead after 13 days. A considerable degree of tolerance was observed at 16‰, the specimens living for one to two months. Loosanoff also found that his specimens often died in normal sea water after varying exposures to low salinities. H. L. Clark (1907) reports a synaptid holothurian from the Philippines, *Protankyra similis* Semper, living in the mud of brackish mangrove swamps, but no salinity data is given. Another holothurian, *Synaptula hydriformis* (Lesueur), occurs in Lovers' Lake, a land-locked body of water on St. George in the Bermudas (H. L. Clark, 1942). This lake apparently has subterranean connections with the sea, and the salinity given for the lake by Clark was 35‰, only 1.4‰ below Bermuda sea-water salinity of 36.4‰. However, Dr. Hilary B. Moore informs the writer that salinities may be considerably lower than 35‰ in Lovers' Lake during periods of heavy rainfall.

In the voluminous literature of estuarine ecology there are many

mentions of these and a few other species penetrating more or less into brackish water, but the writer knows of no echinoderms which exist in salinities lower than those tolerated by *O. filograneus*.

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